3.0 ENVIRONMENTAL SETTING

3.1 CLIMATE

The Allied Fibers Frankford Plant lies within the Pennsylvania Coastal Plain. The climate of the Pennsylvania Coastal Plain is classified as humid continental. The Appalachian Mountains to the west and the Atlantic Ocean to the east have a moderating effect on the climate of this area.

Summers in this region are long and, at times, uncomfortably hot, while winters are comparatively mild. Average monthly temperatures vary from about 31°F in winter to 76°F in summer. Daily temperatures reach 90°F or more an average of 25 days during summer and fall to the freezing point or below on fewer than 100 days during winter. Below-zero and above-100-degree readings are relatively rare, and periods of very high or very low temperatures seldom last for more than three or four days [National Oceanographic and Atmospheric Administration (NOAA), 1982; NOAA, 1983].

Precipitation is fairly evenly distributed throughout the year, with an average annual precipitation of about 41 inches. Maximum rainfall amounts occur during the late summer months, and are often associated with local thunderstorms. Humidity is relatively high, averaging about 57 percent annually, because of the area's proximity to the ocean (NOAA, 1982; NOAA, 1983).

The prevailing wind direction during the summer months is from the southwest and is from the northwest during the winter. The annual prevailing wind direction is from the west-southwest, with an average speed of 9.6 miles per hour (mph) (NOAA, 1982; NOAA, 1983).

3.2 TOPOGRAPHY

The Allied Fibers Frankford Plant property is generally flat to very gently sloping, with short steeply sloping banks immediately adjacent to the Frankford Inlet. The property slopes from north to south toward the former Frankford Creek and the existing Frankford Inlet.

Land surface elevations at the Allied Fibers Frankford Plant range from near sea level at the Frankford Inlet to about 20 feet above mean sea level along the northern boundary of the site adjacent to Interstate 95. The 100-year floodplain at the facility is 4.095 feet Frankford Plant Datum or 10.166 feet above mean sea level. Most of the property south of Main Street and adjacent to the Frankford Inlet and Frankford Inlet sewer right-of-way lies within the floodplain (Kearny, 1987).

3.3 SURFACE WATER HYDROLOGY

Local surface water bodies in the vicinity of the Allied Fibers Frankford Plant include the Frankford Inlet adjacent to the southeastern boundary of the site and the Delaware River located approximately 1/2 mile east of the site. The Frankford Inlet is a tributary of the Delaware River. The river flows to the southwest, toward the Delaware Bay.

Surface water in the Allied facility area falls under the jurisdiction of the states of New Jersey (Delaware River) and Pennsylvania (Delaware River and Frankford Inlet). In this region, surface water is tidal. The state of New Jersey describes its classification of Zone 3 tidal streams as that part of the Delaware extending from river mile (RM) 108.4 to RM 95.0 below the mouth of Big Timber Creek, including the tidal portions of the tributaries thereof (NJDEP, 1989). The commonwealth of Pennsylvania uses the same boundaries when dividing the Delaware River in this area (Pennsylvania Code, Title 25, Chapter 93). The Allied Fibers Frankford Site surface waters of concern fall within these zones. (The Frankford Inlet discharges to the Delaware River at approximately RM 105). The quality of New Jersey Zone 3 waters is maintained for use by public water supplies (after reasonable treatment), industrial water supplies (after reasonable treatment), and agricultural water supplies; the maintenance of aquatic fish and other aquatic life; the passage of anadromous fish; wildlife; recreation-secondary contact; and navigation (NJDEP, 1989). This zone in Pennsylvania, which includes tidal tributaries to the Delaware River in this area (e.g., Frankford Inlet), is protected for the maintenance of warm-water fish, the passage of migratory fish, potable water supply use (after treatment), industrial water use, wildlife water supply, boating, fishing, and navigation (Pennsylvania Code, Title 25, Chapter 93).

Nine surface water intakes were reported in 1988 and 1989 for the Delaware River zone of concern (RM 108.4 to RM 95). All these intakes are for industrial and electrical purposes. A public water supply intake was reported in 1989 for Philadelphia Suburban Water Company for Pennypack Creek, which enters the Delaware River at the border of this zone (RM 108.4, about 3.4 miles upstream from the mouth of the Frankford Inlet). However, this intake was reported to be unused in 1989. There is a New Jersey American Water Company "experimental" public supply intake, listed as unused for 1988 and 1989, reported at RM 109.9. The nearest active public water supply intakes on the Delaware River are all located upstream of the site, and the nearest such intake is reported to be the city of Philadelphia's Torresdale intake at RM 110.5 (DRBC, 1990; DRBC, 1989), about 5.5 miles upstream from the mouth of the Frankford Inlet.

The Frankford Inlet originates on the southeastern perimeter of the site. The inlet was formed when Frankford Creek was channelized west of the site and the former creekbed was backfilled. The Frankford Inlet is a receptor of NPDES-permitted wastewater and storm water discharges from the Allied Frankford Plant, combined sewer system overflow from Philadelphia's Northeast Water Pollution Control plant, and discharges from the nearby Rohm and Haas plant.

Both the Delaware River and Frankford Inlet are tidally influenced in the vicinity of the site. The mean annual tidal range in the Delaware River at Torresdale (approximately 5-1/2 miles upstream of the site) is 6.12 feet. Tides are semidiurnal.

3.4 GEOLOGY AND SOILS

Descriptions of regional geology in the vicinity of the Allied Fibers Frankford Plant are primarily excerpted from "Compilation of Available Site Hydrogeologic Data, Allied Chemical Corporation Frankford Plant" (Weston, 1980) and from "Groundwater Resources of the Coastal Plain Area of Southeastern Pennsylvania" (Greenman, et al., 1961). Descriptions of site-specific geology use information from the same references (Weston, 1980, and Greenman et al., 1961) in conjunction with previous borings drilled on site by Woodward-Clyde in 1982 and 1983 and new information obtained from the RFI Phase I soil boring and monitoring well installation program.

3.4.1 Regional Geology and Soils

The Allied Fibers Frankford Plant is located at the western edge of the Atlantic Coastal Plain Physiographic Province. The Atlantic Coastal Plain is an eastward-thickening wedge of predominantly unconsolidated sediments (e.g., gravel, sand, silt, and clay) extending across the state of New Jersey. The western boundary of this clastic wedge is the Fall Line, which runs roughly in a northeastward-southwestward direction just west of the site.

Underlying the unconsolidated sediments is crystalline basement bedrock of the Pre-Cretaceous Glenarm Series. The basement rocks consist of mica and hornblende schists and gneisses. The bedrock complex is a poor aquifer in the Coastal Plain area, but some groundwater can be found in secondary fractures. Weathering has produced a residual clay (saprolite) at the upper surface of the basement complex. This residual clay, when continuous, forms a confining bed that limits the exchange of groundwater between the crystalline rock beneath and alluvial deposits above.

The basement bedrock complex is unconformably overlain by the Raritan Formation (of Cretaceous age). In Pennsylvania, the Raritan Formation is represented by a sequence of nonmarine deposits representing three cycles of deposition. Each cycle contains a basal layer of coarse-grained (sand and gravel) deposits that are covered by layers of silts and clays. The coarse-grained materials are capable of yielding moderate to large volumes of groundwater to wells, whereas the silt and clay layers tend to protect the aquifers by inhibiting the direct flow of water between them.

In the Coastal Plain of Pennsylvania, Quaternary deposits cover the Cretaceous deposits. These Quaternary deposits include sediments of the Pleistocene (the recent "ice ages") and Recent (post "ice age") epochs. The Pleistocene deposits are predominantly composed of coarse sand and fine to medium gravel. They are extremely heterogeneous and consist of a wide variety of grain sizes, including considerable amounts of fine-grained clayey material. The Recent deposits consist primarily of richly organic, dark gray mud; silt; and fine sand. These deposits underlie the channels and tidal flats of the Delaware River and its principal tributaries (Greenman, et al., 1961).

In Weston (1980) and Greenman, et al. (1961), boring logs from wells drilled in the vicinity of the plant were correlated to develop a local geologic framework. These boring logs are provided on Figure 3-1.

In the area near the southeastern boundary of the site, the basement bedrock complex is believed to be overlain unconformably by the upper Cretaceous age Farrington Sand and Lower Clay members of the Raritan Formation. The Farrington Sand member, which directly overlies bedrock, is primarily composed of fairly well-sorted coarse sand to fine gravel. The grain size decreases somewhat upward within the member, and a few beds of white clay are found near the top of the member. The sand varies in color from yellowish gray to pale yellowish brown. Greenman, et al. (1961) speculated that the Farrington Sand member may have been eroded within or near the southeastern portion of the site.

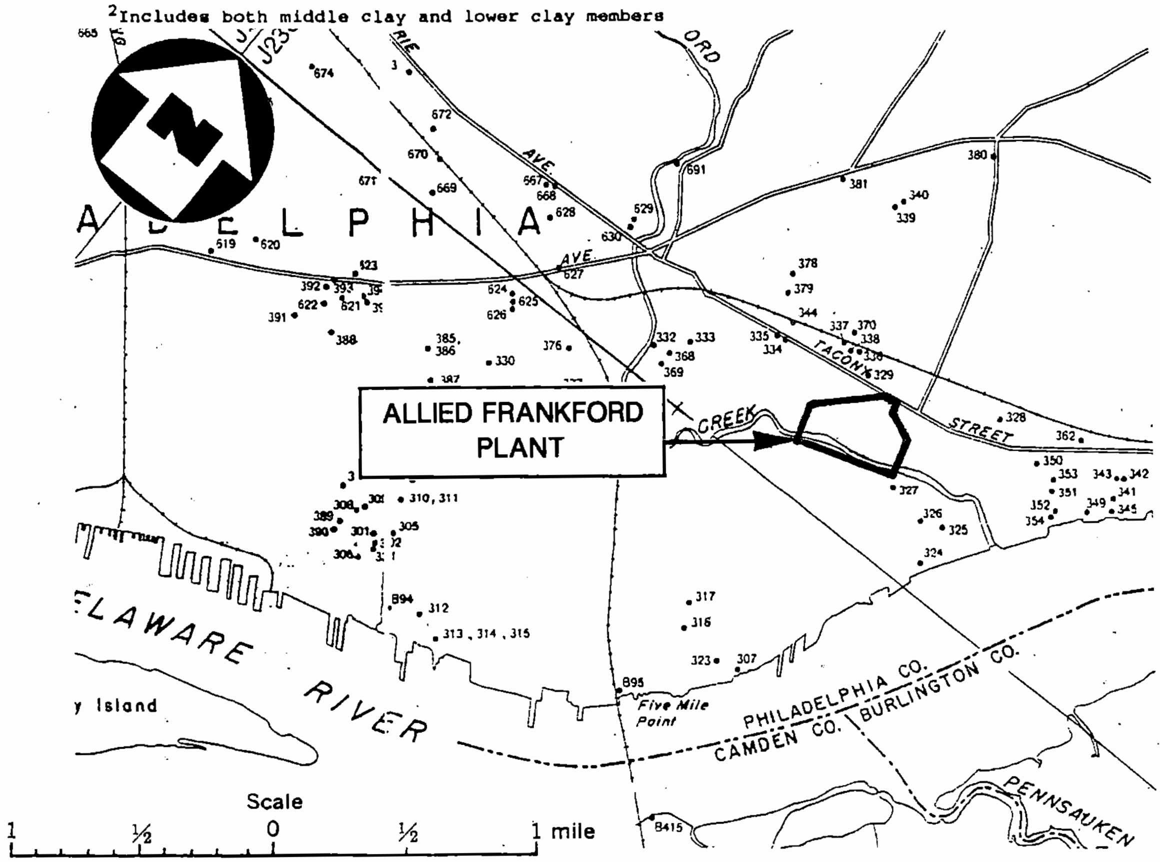
The Lower Clay member consists primarily of a layer of yellow sandy clay material. This member includes beds of stratified clay interbedded with thin lenses of silt and fine sand. The borings shown on Figure 3-1 indicate approximately 20 feet of the Lower Clay member present near the southeastern boundary of the site. Greenman, et al. (1961) showed that this Lower Clay member may have been eroded in the subsurface 1,000 feet north of the site boundary. Where present, the continuity of the Lower Clay member provides a confining bed that prevents free exchange of water between the Farrington Sand member and the water-bearing zones above.

Pleistocene sands and gravels are approximately 20 feet thick southeast of the site. No fill or recent sediment thickness estimates were provided by Weston (1980) or Greenman, et al. (1961).

Soils in the area of the Allied Fibers Frankford Plant are of the Urban land - Howell Association. The plant locale is an area of nearly level to gently sloping soils formed in loamy and clayey material of mixed, old Coastal Plain sediment. Urban land consists of areas that are built up and occupied by urban structures. Howell and other soils have been obscured, smoothed, disturbed, filled in, or destroyed by the construction of urban facilities. Howell soils are deep and well drained, have a moderately slow permeability, and consist of silt loam and silty, sandy, or gravelly clay loam [United States Department of Agriculture (USDA), 1985].

Well number		Ph-327	Ph-324	Ph-325	Ph-326
Source of log		Layne-New York	Layne-New York	Layne-New York	Layne-New York
Altitude (msl)		10 feet	11 feet	10 feet	18 feet
Total Depth (feet)		44	67	80	65
Quaternary Rocks Recent (undifferentiated)					
Pleistocene (undifferentiated)		0-19 feet; sand and gravel	0-25 feet; sand and gravel	0-25 feet; sand and gravel	0-25 feet sand and gravel
Cretaceous Rocks Raritan Formation	Upper clay member				
	Old Bridge sand member				
	Middle clay member	19-38 feet[2]; yellow sandy clay	25-45 feet[2]; yellow and sandy clay	25-40 feet[2]; yellow and brown clay	25-45 feet ; yellow and red sandy clay
	Sayreville sand member				
	Lower clay member				
	Farrington sand member	38-43 feet; coarse sand and gravel	45-65 feet; sand and gravel	40-60 feet; fine brown sand and gravel	45-58 feet; brown sand and clay
Crystalline rocks		43-44 feet; yellow clay and mica	65-67 feet; rock	60-80 feet; mica rock	58-65 feet; mica rock

[2]Includes both middle clay and lower clay members



SOURCE: GREENMAN, et al., 1961.

FIGURE: 3-1

.OGS OF BORINGS LOCATED IN CLOSE PROXIMITY TO ALLIED FRANKFORD PLANT SITE

ALLIED FIBERS FRANKFORD PLANT

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3.4.2 Site Geology

Sixty soil borings and three monitoring well borings were drilled at the Frankford Plant during the RFI Phase I fieldwork. Logs from the borings containing lithologic descriptions and other information are contained in Appendix B. The locations of the borings and monitoring wells are shown in Figure 3-2.

In addition to the RFI Phase I borings, Woodward-Clyde Consultants, in 1982, installed borings for a geotechnical investigation for a proposed sump and elevated pipe rack to be located between Wakeling Street on the west and Phenol Unit No. 1 on the east (boring nos. B-1, B-2, and B-3 on Figure 2-1). In the three test borings, Woodward-Clyde encountered zero to 6.5 feet of fill (stratum 1) underlain by two to 7.5 feet of brown to dark gray sandy, gravelly, silty clay to clayey silt (stratum 2A), underlain by 17 to 21.5 feet of brown gravelly, silty, coarse to fine sand that grades with depth to a coarse to fine sand and gravel (stratum 2B), underlain by brown, black, and/or green sandy, clayey silt (stratum 2C). In one boring, decomposed mica schist was encountered at a depth of 29 feet (Woodward-Clyde, 1982). Logs of boring nos. B-1, B-2, and B-3 are included in Appendix B.

Also, in 1983, Woodward-Clyde conducted a boring program to assess the caustic spill area. The following strata were encountered in descending order: approximately 12 to 23 feet of miscellaneous silty fill materials overlying 12 to 20 feet of gray organic silt, which overlay about five to eight feet of sand and gravel overlying schist bedrock (Woodward-Clyde, 1983). No drilling logs from these borings are available.

Lithologic descriptions of samples from the RFI Phase I borings have been used in combination with the available background information to create a geologic model of the Allied Fibers Frankford Plant. This model consists, in descending order, of three basic units: surficial fill deposits, unconsolidated alluvial deposits, and the underlying saprolite and bedrock. The unconsolidated alluvial deposits are further subdivided into an upper sand and gravel unit, a silt-clay unit, and a lower sand and gravel unit. The general configuration of the geologic interpretation and individual geologic units is illustrated by two approximately perpendicular cross-sections (see Figure 3-2 for the locations of the cross-sections). Cross-section A-A' (see Figure 3-3) extends from northwest to southeast, roughly perpendicular to the geologic contacts of the area. Cross-section B-B' (Figure 3-4) extends from west to east and is subparallel to the geologic contacts of the area.

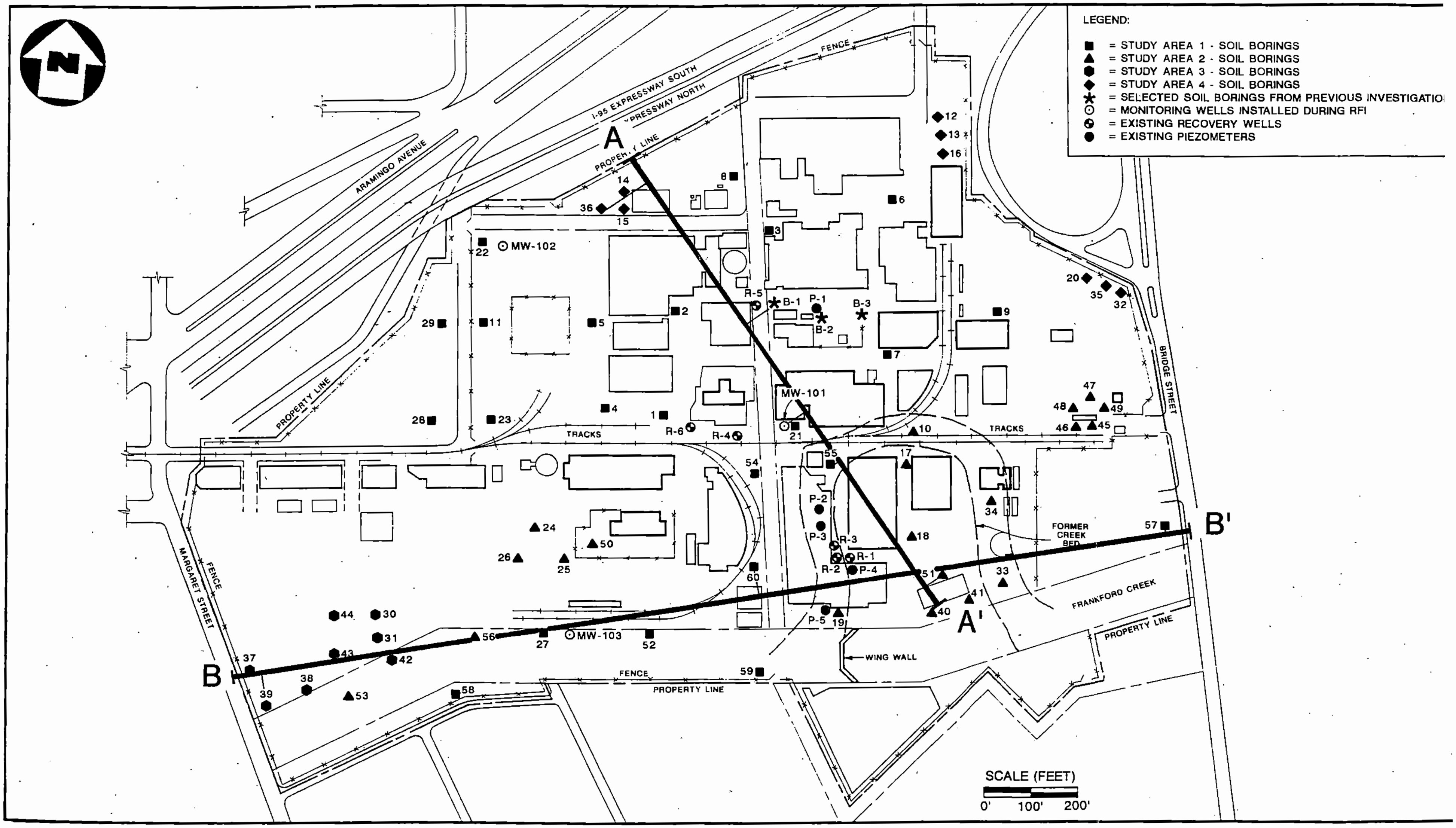

FIGURE: 3-2

LOCATION OF GEOLOGIC CROSS SECTIONS
ALLIED FIBERS FRANKFORD PLANT

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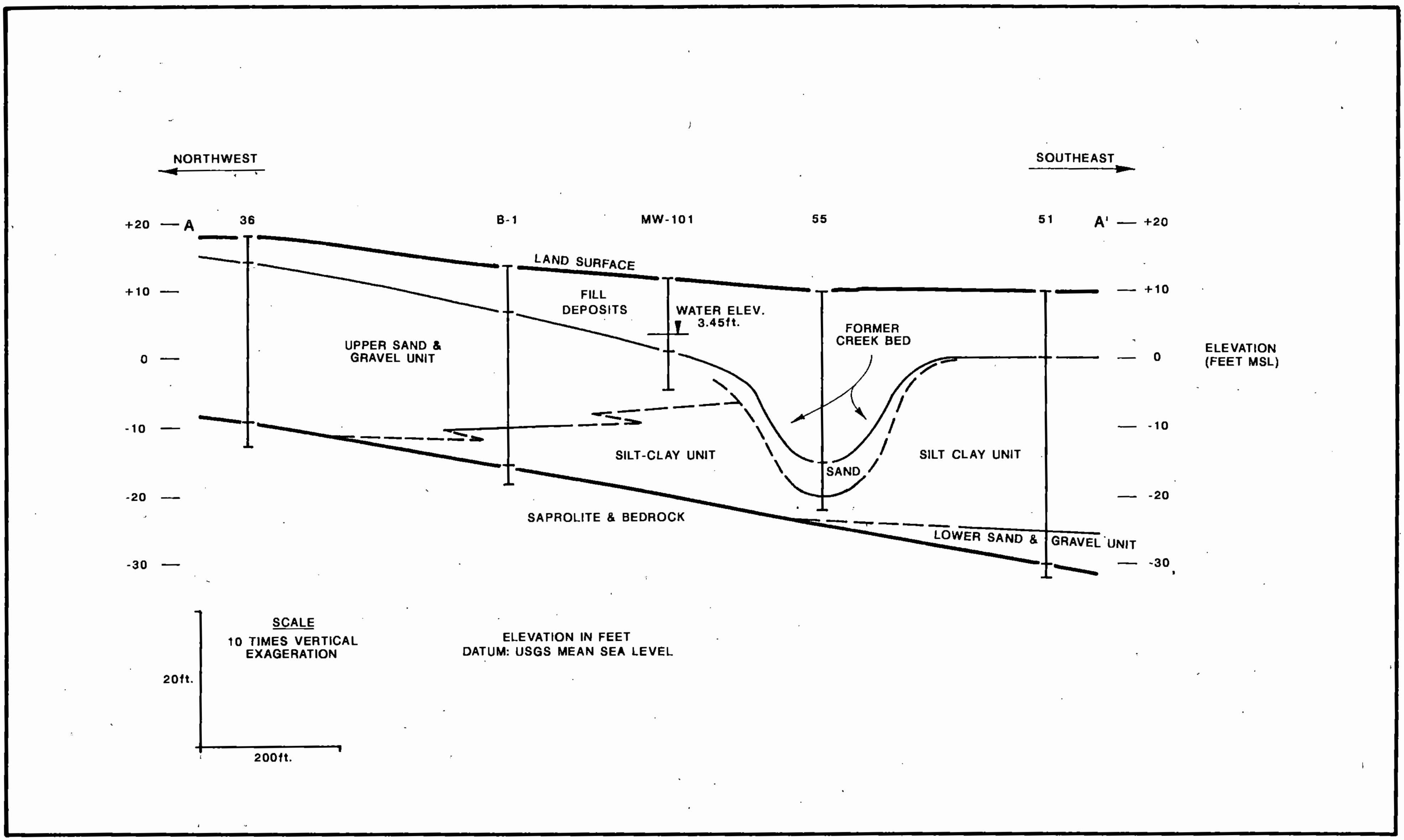

FIGURE: 3-3

CROSS SECTION A - A'

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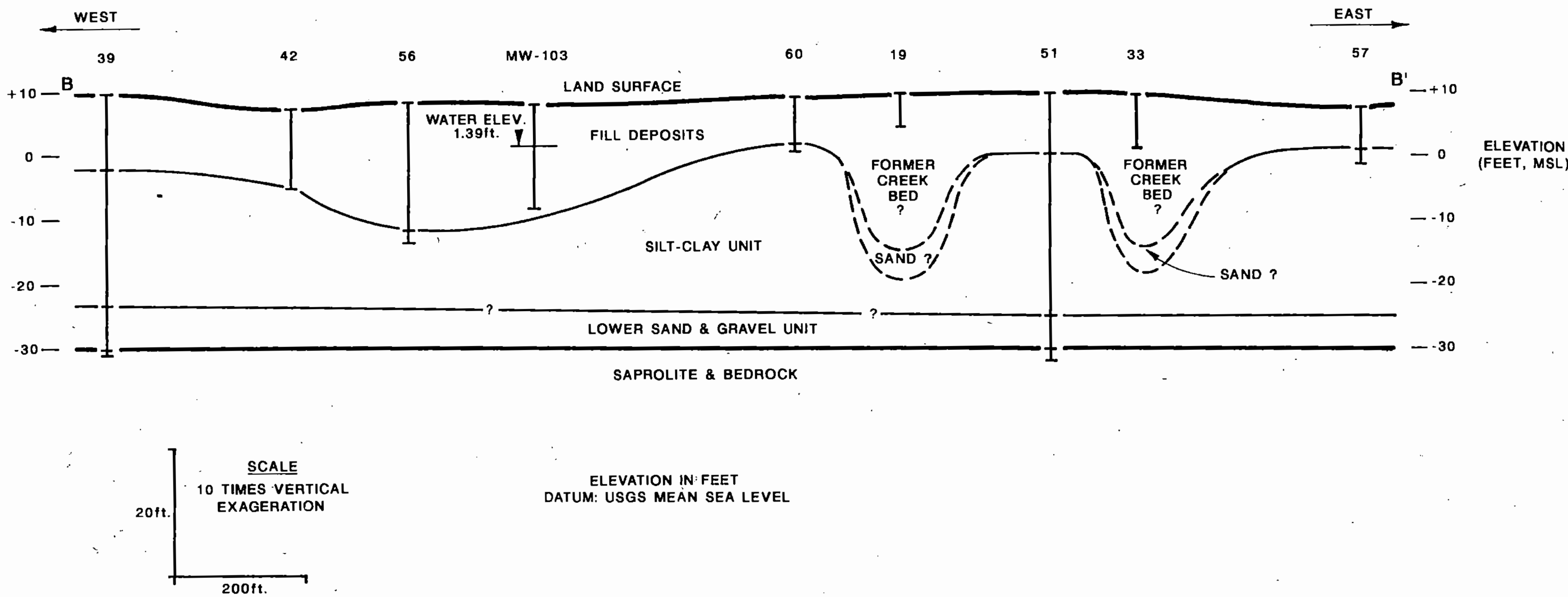

CROSS SECTION B - B'

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FIGURE: 3-4

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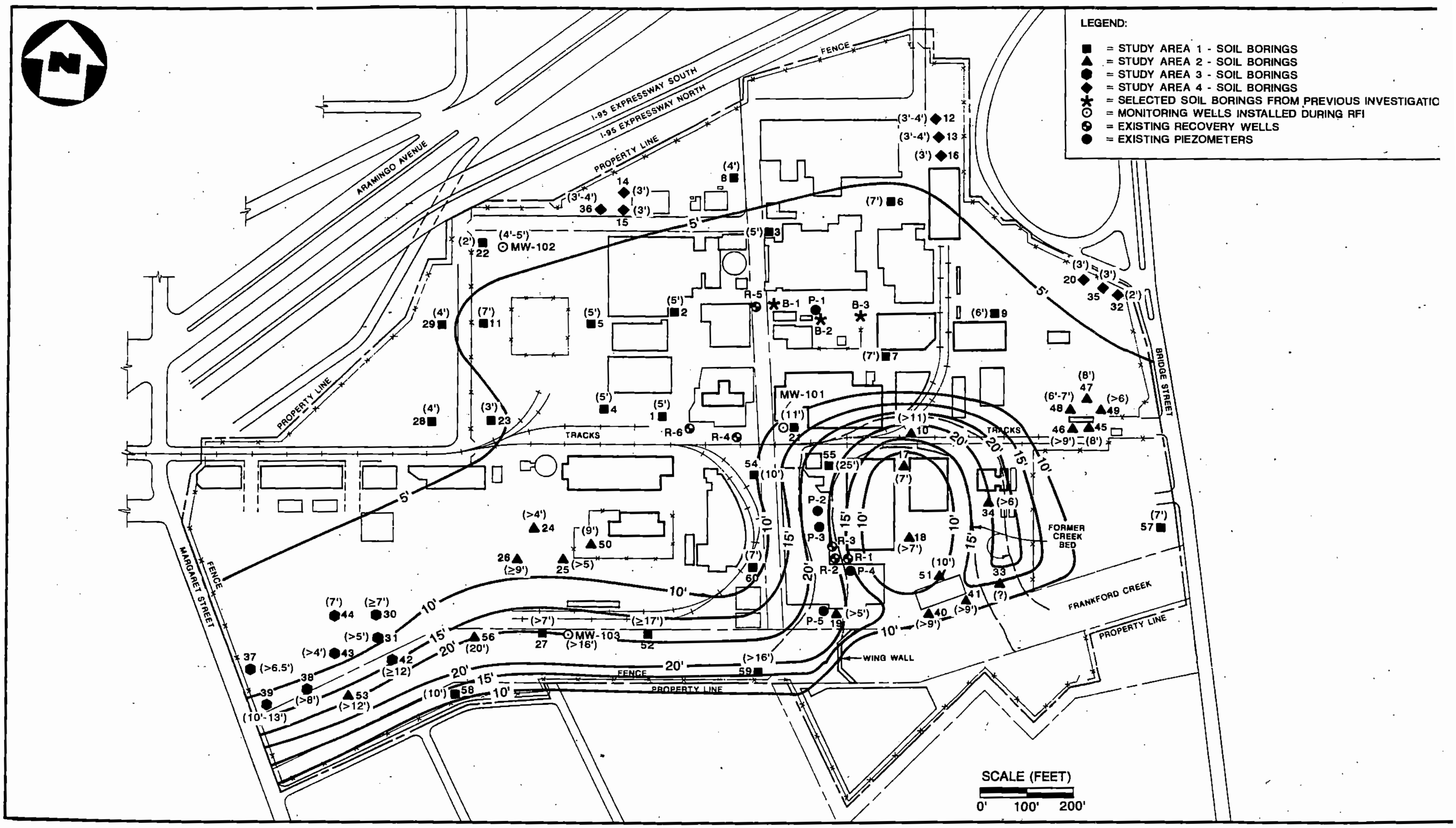
3.4.2.1 Surficial Fill Deposits

Lithologic descriptions from soil borings indicate that anywhere from two feet to over 20 feet consist of fill material are present at the facility. The fill deposits are approximately five feet or less thick along the northern boundary of the plant and increase to more than 20 feet along the axis of the filled former creekbed of Frankford Creek. Figure 3-5, a map of approximate fill thickness, is based on the results of the soil boring programs. The thickness and distribution of the fill deposits are also shown on the geologic cross-sections (Figures 3-3 and 3-4). Local areas of fill deposit thickness greater than those shown on Figure 3-5 are expected to occur throughout the facility. These areas would occur where excavations were made for the construction of buildings and the installation of sewers and other underground utility lines or structures.

The areas of greatest fill thickness (see Figure 3-5) conform closely with the location of the filled channel of the former Frankford Creek. Borings in the former creekbed area encountered about 12 to 23 feet of miscellaneous silty fill materials (Woodward-Clyde, 1983).

The gradual increase of the fill deposit thickness from the northern part of the facility toward the southern part adjacent to the former Frankford Creek (see Figure 3-5) is consistent with the geographic setting of the Allied Fibers Frankford Plant. Comparisons of the site geology with undeveloped areas adjacent to tidally influenced tributaries of the Delaware River indicate that the southern portion of the plant was probably a tidal flat, marsh, or low floodplain prior to urban development. It is reasonable to assume that the southern part of the site received greater thicknesses of fill material in order to provide a more stable base of sufficient elevation for the construction of buildings and plant facilities.

The composition of the fill deposits encountered throughout the site is highly variable and includes natural soil and alluvial material, and man-made debris and waste. The natural alluvial and soil materials in the fill consist of silt, clay, sand, gravel, pebbles, and cobbles. The more common man-made debris and waste materials in the fill deposits are crushed stone and rock fragments, brick and concrete fragments, coal, tarry residues, and ashy material. Less common constituents of the fill include slate, tile, glass, plastic and shell fragments, wood, steel reinforcing bar, steel and copper wire, metal shavings, nails, black tarry sludge-like substances, cement grout, fibrous material similar to horse hair, and a white, tan, or brown crystalline solid suspected to contain naphthalene. Some fill components are present throughout the facility, and others occur only in particular areas. More detailed descriptions of the composition of the fill deposits are included in the site characteristics sections for the individual study areas (Sections 4.3, 5.3, 6.3, and 7.3).



APPROXIMATE FILL THICKNESS - FEET

ALLIED FIBERS FRANKFORD PLANT

FIGURE: 3-5

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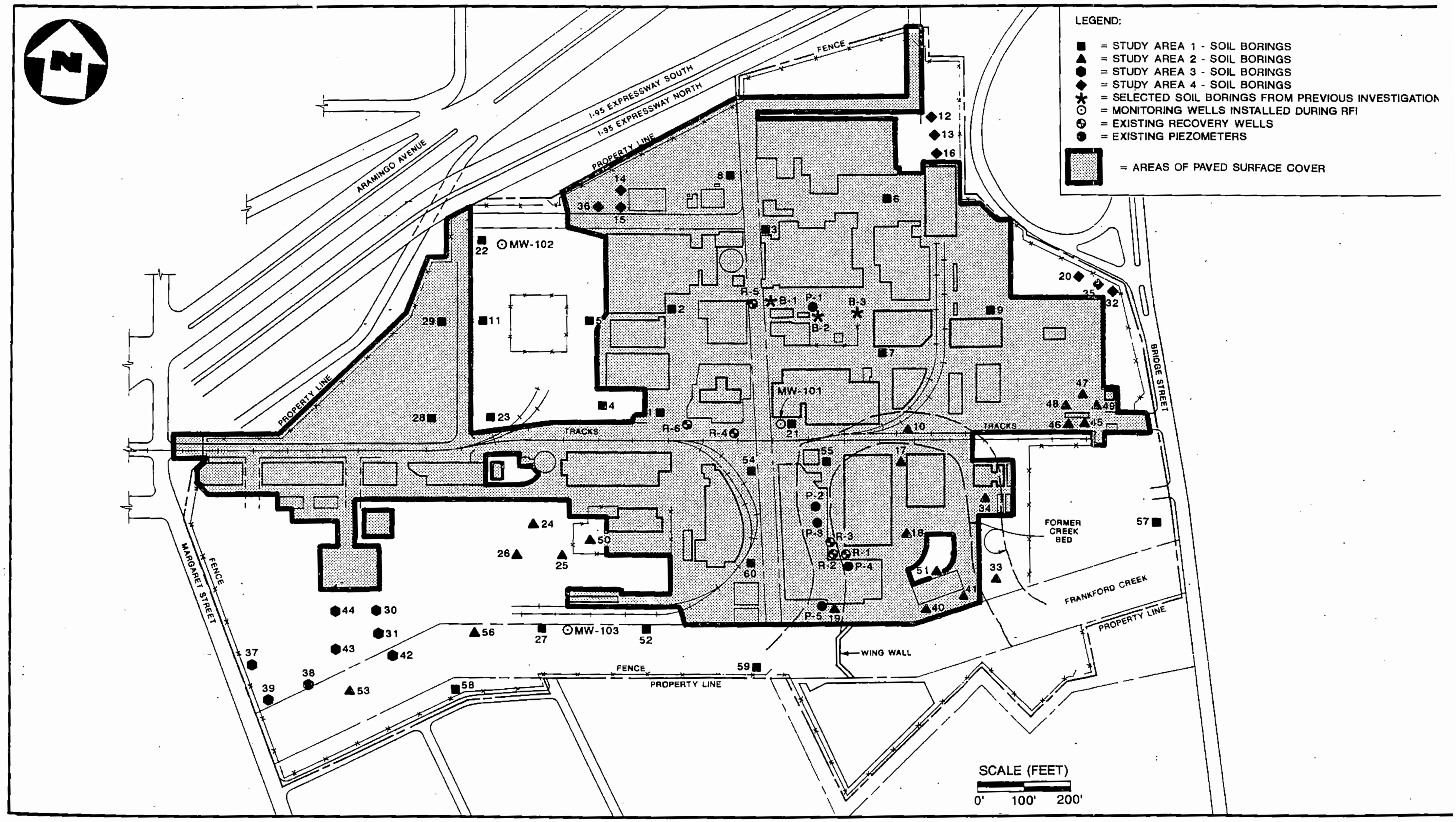
The fill deposits are overlain by areas of man-made, low permeability surface cover throughout more than half the facility. These areas include buildings, concrete surfaces, containment structures underlying all tanks and process facilities, roads, parking lots, and other surfaces paved with asphalt. Figure 3-6 shows the areas of man-made, low permeability surface cover within the Allied Fibers Frankford Plant. Almost all areas not overlain by structures or paved areas are covered by several inches of crushed stone or gravel.

Grain size distribution analyses were performed on four samples of the unsaturated fill deposits. Grain size distribution analytical results are included in Appendix A; the grain size distribution of the samples are shown below.

Material (grain size)	Sample No. SO39-02	Sample No. SO51-03	Sample No. SO55-03	Sample No. SO56-04
Coarse Gravel (more than 3/4 inch)	7.3	6.1	0.0	0.0
Fine Gravel (3/4 inch to No. 4 sieve)	29.1	4.4	5.4	29.2
Coarse Sand (No. 4 to No. 10 sieve)	11.0	2.7	13.4	13.9
Medium Sand (No. 10 to No. 40 sieve)	20.2	10.1	29.2	19.2
Fine Sand (No. 40 to No. 200 sieve)	13.7	16.3	28.9	15.1
Silt and Clay less than No. 200 sieve)	18.7	60.4	23.1	22.6

As can be seen, the fill deposits are somewhat poorly to poorly sorted and show significant variation between sample locations. All samples contained some gravel, sand, silt, and clay-sized particles. Some samples contain almost equal amounts of these different materials, while others are composed predominantly of particles within a particular range of grain sizes.



PAVED SURFACE COVER MAP

ALLIED FIBERS FRANKFORD PLANT

FIGURE: 3-6

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3.4.2.2 Unconsolidated Alluvial Deposits

All Phase I RFI soil borings and monitoring well installation borings that completely penetrated the surficial fill deposits encountered unconsolidated alluvial deposits. The same is true of soil borings performed by Woodward-Clyde Consultants in 1982 and 1983 (Woodward-Clyde, 1982; Woodward-Clyde, 1983). The lithologic descriptions available from these soil boring programs indicate that the unconsolidated alluvial deposits can be subdivided into three basic lithologic units: the upper sand and gravel, silt-clay, and lower sand and gravel units. The known or postulated relationships between these three units are shown in the geologic cross-sections (Figures 3-3 and 3-4).

The three lithologic units of the unconsolidated alluvial deposits have been assigned based on similarities in lithology and the positions they occupy relative to one another, to the overlying fill deposits, and to the underlying saprolite and bedrock. The upper sand and gravel unit was found to be underlying the fill deposits and overlying either the silt-clay unit or the saprolite and bedrock. The silt-clay unit was found to be underlying either the fill deposits or the upper sand and gravel unit and overlying either the lower sand and gravel unit or the saprolite and bedrock. The lower sand and gravel unit was found to be underlying the silt-clay unit and overlying the bedrock and saprolite. The exact stratigraphic relationship between these three units (the specific geologic ages and formation or member assignments and any lateral and/or vertical gradations in lithology) cannot be determined from the existing data.

Upper Sand and Gravel Lithologic Unit

The upper sand and gravel unit consists of a heterogeneous mixture of fine- to coarse-grained sand, fine to coarse gravel, rounded pebbles and small cobbles, silt, and clay. It is typically brown to light gray in color. Sand and gravel are the most common constituents of this unit; however, significant amounts of silt and clay are present in the upper portions of the unit in the northern part of the site. Grain size and degree of sorting vary considerably, both laterally and vertically, within the unit. Some well-sorted layers of sand or silty clay and clay are present up to several inches thick. The upper sand and gravel unit was found in soil borings throughout the portion of the Allied Fibers Frankford Plant north of Main Street except for the area surrounding the truck scale near the Bridge Street entrance (boring nos. 45 through 49). The maximum unit thickness, 23 feet, was contained in boring no. 36, where the unit extends from the base of the fill deposits to the top of the bedrock and saprolite. In borings B-1, B-2, and B-3, installed by Woodward-Clyde in 1982, the upper sand and gravel unit (Woodward-Clyde Strata 2A and 2B), extends from the base of the fill to the top of the silt-clay lithologic unit (Stratum 2C) (Woodward-Clyde, 1982). None of the other borings in which the upper sand and gravel unit was found penetrate its entire thickness. Several borings in the southern part of the plant penetrated the fill deposits and the silt-clay unit without encountering the upper sand and gravel unit. This fact suggests that the upper sand and gravel unit thins and disappears from north to south within the site, as depicted in cross-section A-A' (Figure 3.3). The exact nature and location of the southern boundary of the upper sand and gravel unit cannot be determined from the available data.

Some of the soil borings located south of Main Street also encountered sandy deposits underlying the known fill deposits. Boring nos. 26 and 30 contained a few inches of pebbly sand and fine-grained silty sand, respectively, beneath the fill materials at total depth. Boring no. 54 contained approximately five inches of sand and gravel between the fill and the underlying silt-clay unit. Boring nos. 55 and 56 contained approximately five feet and seven inches of well-sorted sand, respectively, between the fill and silt-clay units. Boring no. 60 contained about 12 inches of silty clay interbedded with sandy clay and pebbles. The correlation between these sandy deposits and the upper sand and gravel unit in the northern part of the site is uncertain. They may represent the southernmost extent of the upper sand and gravel unit and/or Recent deposits from the former Frankford Creek. The sandy deposits may also represent fill deposits misinterpreted as alluvial deposits or localized sandy intervals within the silt-clay unit.

Grain size distribution analyses were performed on two samples from the upper sand and gravel unit in boring no. 36 and on a sample from the sand interval in boring no. 55. Grain size distribution analytical results are included in Appendix A; the general composition of the samples based on these analyses are shown below.

Material (Grain Size)	Sample No. SO36-09	Sample No. SO36-25	Sample No. SO55-30
Coarse Gravel (more than 3/4 inch)	0.0	0.0	0.0
Fine Gravel (3/4 inch to No. 4 sieve)	1.0	11.3	3.3
Coarse Sand (No. 4 to No. 10 sieve)	1.8	10.6	7.4
Medium Sand (No. 10 to No. 40 sieve)	21.2	36.2	43.4
Fine Sand (No. 40 to No. 200 sieve)	36.5	34.1	36.4
Silt and Clay (less than No. 200 sieve)	39.5	7.8	9.5

The amount of heterogeneity with regard to both grain size and degree of sorting is partially illustrated by these results. The sample classifications ranged from silty sand to poorly sorted gravelly sand to moderately well-sorted fine- to medium-grained sand.

Silt-Clay Lithologic Unit

The silt-clay lithologic unit consists of relatively homogeneous, soft, and plastic deposits of silt and clay-sized particles, with trace amounts of sand, gravel, and pebbles. Significant amounts of natural organic matter, including leaves, peat, or other plant material, are usually present. A fibrous material similar to horse hair is occasionally found in the uppermost part of the silt-clay unit near the contact with overlying fill deposits. The color of the unit is usually dark greenish-gray, dark grayish-brown, or black within the southern part of the site near the former Frankford Creek channel. The unit is typically brownish in the northern occurrences of the silt-clay unit away from the former Frankford Creek channel.

The northernmost documented occurrence of the silt-clay unit was in three soil borings drilled by Woodward-Clyde Consultants in 1982 (boring nos. B-1, B-2, and B-3 on Figure 3-7). The descriptions of the silt-clay unit from the boring logs are as follows (Woodward-Clyde, 1982):

- B-1: Stiff, dark brown and black fine sandy clayey silt
- B-2: Stiff, brown fine sandy clayey silt
- B-3: Stiff, brown and green coarse to fine gravelly sandy clayey silt

Soil borings in the caustic spill area of the facility revealed about 12 to 20 feet of gray organic silt underlying the fill deposits at a depth of 12 to 23 feet (Woodward-Clyde, 1983).

The known distribution of the silt-clay unit is shown in Figure 3-7; areas that are not known to be underlain by the silt and clay deposits are also shown. The undefined areas on Figure 3-7 occur where the soil borings did not reach sufficient depths to determine whether or note the silt-clay unit is present underlying the upper sand and gravel unit. Only boring nos. 39, 51, and B-1 have completely penetrated the silt-clay unit; the maximum recorded thickness of the unit is about 25 feet in boring no. 51. In both boring nos. 39 and 51, the silt-clay unit directly underlies the fill deposits and overlies the lower sand and gravel unit. In boring B-1, the silt-clay unit underlies the upper sand and gravel unit and overlies the saprolite and bedrock. The exact boundaries and stratigraphic relationships between the silt-clay unit and the other lithologic units within the site cannot be determined from the available data.

Grain size distribution analyses were performed on three samples from the silt-clay unit. Grain size distribution analytical results are included in Appendix A, and the general composition of the samples based on these analyses are shown below.

Material (Grain Size)	Sample No. SO39-20	Sample No. SO51-25	Sample No. SO56-20
Coarse Gravel (more than 3/4 inch)	0.0	0.0	0.0
Fine Gravel (3/4 inch to No. 4 sieve)	0.2	0.0	0.0
Coarse Sand (No. 4 to No. 10 sieve)	0.5	0.0	0.0
Medium Sand (No. 10 to No. 40 sieve)	0.8	0.8	1.4
Fine Sand (No. 40 to No. 200 sieve)	1.2	1.8	4.2
Silt and Clay (less than No. 200 sieve)	97.3	97.4	94.4

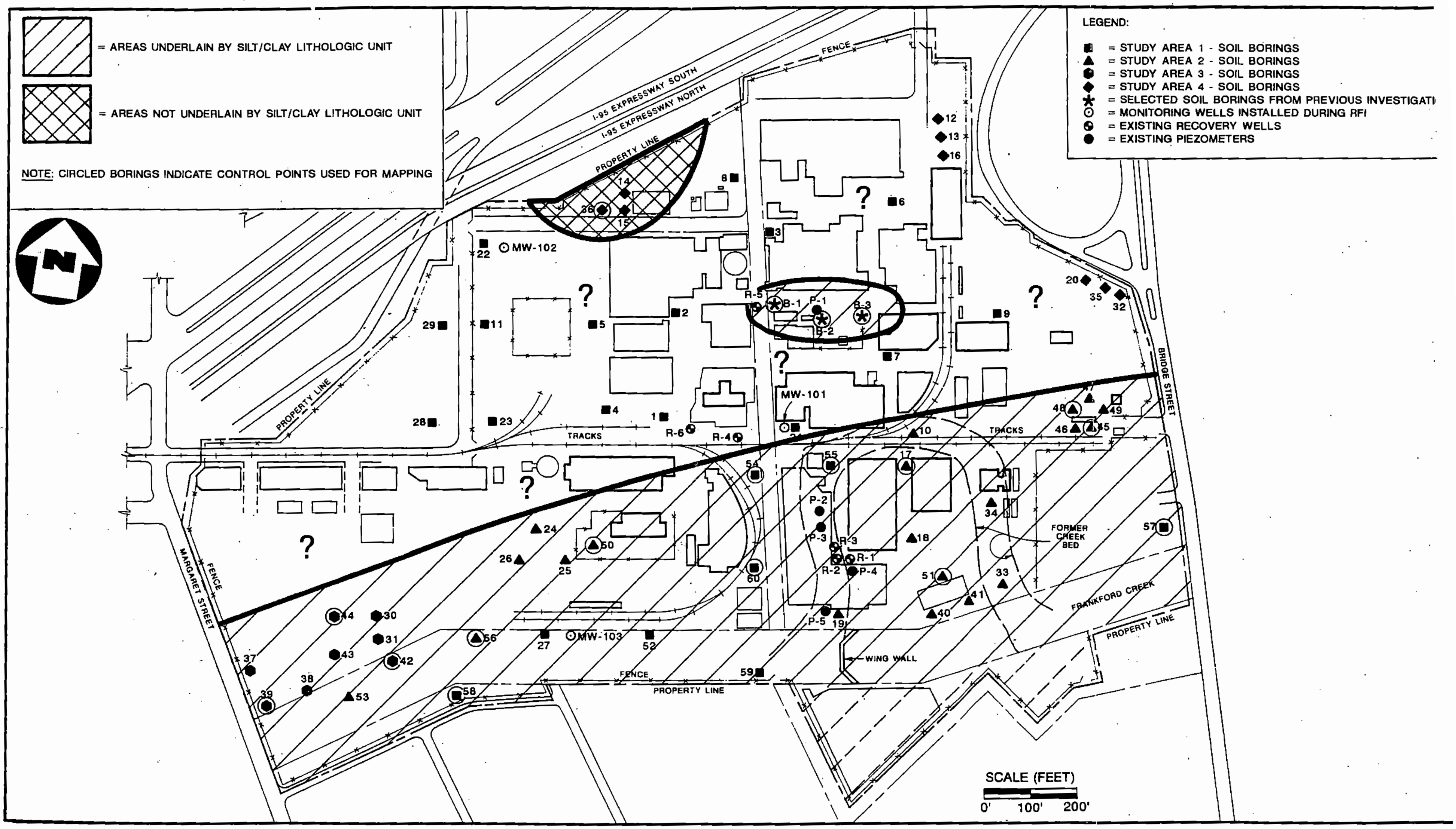

FIGURE: 3-7

APPROXIMATE DISTRIBUTION OF SILT-CLAY LITHOLOGIC UNIT

ALLIED FIBERS FRANKFORD PLANT

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Lower Sand and Gravel Lithologic Unit

The lower sand and gravel unit consists of gray to brown sand and gravel, with rounded pebbles, small cobbles, and slight amounts of silt and clay. The sands range from fine to coarse grained. The degree of sorting is generally poor; however, some well-sorted sands are present. No samples of the lower sand and gravel unit were collected for grain size distribution analysis.

The lower sand and gravel unit was identified in only two of the Phase I RFI soil borings (nos. 39 and 51) and is present underlying the silt-clay unit and overlying the saprolite and bedrock. The unit is approximately five to six feet thick at these locations. Results from a boring program in the caustic spill area of the facility report the presence of about five to eight feet of sand and gravel between the silt-clay deposits and the schist bedrock (Woodward-Clyde, 1983). A lower sand and gravel unit was not present in boring B-1 between the silt-clay unit and the underlying decomposed mica schist (Woodward-Clyde, 1982). Neither the silt-clay unit nor a distinct lower sand and gravel unit was encountered in boring nos. 36 before reaching bedrock.

The lower sand and gravel unit appears to be present only in the southern part of the site between the silt-clay unit and the underlying saprolite and bedrock (see Figure 3-3). However, it is not possible to determine the true extent of this unit or its stratigraphic relationship with respect to the other lithologic units present within the Frankford Plant boundaries.

Stratigraphy of Unconsolidated Alluvial Deposits

The physical arrangement of the three lithologic units of the unconsolidated alluvial deposits implies a stratigraphic framework in which the silt-clay unit overlies the lower sand and gravel unit and is overlain by the upper sand and gravel unit. Such a stratigraphic framework cannot be documented using the available data. None of the three units is present throughout the entire area of the site, and no single boring has encountered all three units. Furthermore, the distribution of existing soil borings and lithologic samples is not sufficient to fully evaluate lateral and vertical lithologic gradations within individual units or the extent of erosion and later sediment deposition in particular areas.

Some comparisons and hypothetical correlations can be drawn between the lithologic units found at the Allied Fibers Frankford Plant and the regional and local stratigraphic framework described in the "Compilation of Available Site Hydrogeologic Data, Allied Chemical Corporation Frankford Plant" (Weston, 1980) and "Groundwater Resources of the Coastal Plain Area of Southeastern Pennsylvania" (Greenman, et al., 1961).

The lithology, thickness, depth, and elevation of the lower sand and gravel unit encountered in the Phase I RFI borings are all similar to the descriptions of the Farrington Sand member of the Raritan Formation described in nearby wells southeast of the site (see Figure 3-1) (Greenman, et al., 1961). Both the lower sand and gravel unit and the Farrington Sand member overlie bedrock or saprolite and underlie silty clay or clay deposits. The most plausible interpretation, based on local and regional geology, is that the lower sand and gravel unit encountered during the Phase I RFI correlates with the Farrington Sand member of the Raritan Formation described by Greenman, et al. (1961).

In this interpretation, the Farrington Sand member is present only within the southern portion of the Frankford facility and pinches out somewhere within the central portion of the site. Such an interpretation is consistent with the extent of the Farrington Sand member in geologic maps of the area (Greenman, et al., 1961). Additional geologic investigation would be required to verify this interpretation.

The thickness and depth of the silt-clay unit encountered during the Phase I RFI are similar to those of the Lower Clay, Sayreville sand, and middle clay members, undivided, of the Raritan Formation described in nearby wells southeast of the site (see Figure 3-1) (Greenman, et al., 1961). Each of these units is also found directly overlying what was interpreted to be the Farrington Sand member of the Raritan Formation. The location of the silt-clay unit at the Allied Fibers Frankford Plant falls within the area occupied by the lower through middle clay members of the Raritan Formation, according to geologic maps of the area (Greenman, et al., 1961).

The northernmost occurrences of the silt-clay unit at the Allied Fibers Frankford Plant were described primarily as brown sandy clayey silt (Woodward-Clyde, 1982). This description is relatively similar to the yellow sandy clay described in the lower through middle clay members of the Raritan Formation described in logs from nearby wells (see Figure 3-1). The silt-clay unit encountered in the southern part of the Frankford Plant is primarily a soft organic, dark greenish-gray clay or silty clay. This description is different from the description of the lower through middle clay members of the Raritan. In terms of lithology, the southern part of the silt-clay unit at the Allied Fibers Frankford Plant more closely resembles Recent alluvial deposits. This possibility is consistent with the location of these deposits underlying and in proximity to the former Frankford Creek. It is also suggested by the fact that fill materials are present within some samples from the uppermost part of the silt-clay unit.

The available data suggest conflicting stratigraphic correlations for the silt-clay unit of the Allied Fibers Frankford Plant. The depth, thickness, extent, and structural position of the unit suggest that it represents the lower through middle clay members of the Raritan Formation. The lithology and geographic setting suggest that at least part of the unit may represent Recent alluvial deposits related to the former Frankford Creek. It is possible that the silt-clay unit encountered at the Frankford Plant is composed of sediments from both the lower through middle clay members of the Raritan Formation and from Recent alluvial deposits. Definitive stratigraphic correlation of the silt-clay unit would require additional geologic investigation.

The elevation of the upper sand and gravel unit within the Allied Fibers Frankford Plant with respect to the elevation of the various members of the Raritan Formation in the area suggests that these are Quaternary age alluvial and outwash deposits (Greenman, et al., 1961 and Weston, 1980). This conclusion would be further supported if the underlying silt-clay unit, where present, were determined to be of the Raritan Formation. The lithologic description of the upper sand and gravel unit corresponds most closely with that of the Pleistocene deposits; however, there is no evidence to indicate that part of the unit could not also be composed of Recent deposits. The absence of the upper sand and gravel unit in the southern part of the site could be due to either erosion or non-deposition. The exact relationship and definition of the contact between this unit and the described Raritan Formation or Recent deposits would require further investigation.

3.4.2.3 Saprolite and Bedrock

Saprolite and bedrock were encountered in all three of the Phase I RFI soil borings advanced to bedrock. In boring no. 36, the top of the saprolite layer was interpreted to occur at an approximate depth of 27.5 feet, based on changes in the drilling rate. A sample of the saprolite contained quartz, feldspar, clay, mica, traces of pyrite, and fragments of weathered schist and gneiss bedrock. Sample refusal on bedrock occurred at a depth of 30 feet. In boring no. 39, auger refusal on bedrock occurred at a depth of 41 feet. Traces of weathered quartz and feldspar gneissic material were found in mud on the auger bit. An increased clay content and distinct color change from gray to brown encountered at a depth of approximately 40 feet may indicate the top of the saprolite layer. In boring no. 51, auger refusal on bedrock occurred at a depth of 42 feet. No samples of saprolite or bedrock were obtained. The available samples indicate that the saprolite layer, if present, would have a maximum thickness of about one foot.

For soil boring no. B-1, it was reported that decomposed mica schist was encountered at a depth of 29 feet (Woodward-Clyde, 1982).

Descriptions from a boring program in the caustic spill area (near well nos. R-1, R-2, and R-3, see Figure 2-1) indicate that schist bedrock underlies the unconsolidated alluvial deposits; however, the depth to bedrock was not reported (Woodward-Clyde, 1983).

The elevation of the bedrock surface ranges from approximately nine feet below mean sea level in the northern part of the site to approximately 30 feet below mean sea level in the southern part of the site near the Frankford Inlet and former Frankford Creek channel. Within the Frankford Plant property, the bedrock surface dips gently to the south-southeast, as illustrated by the geologic cross-sections A-A' and B-B' in Figures 3-3 and 3-4, respectively.

Descriptions of the bedrock material and depths from the soil borings are consistent with the regional geologic descriptions. The available soil boring data indicate that the saprolite layer at the upper bedrock surface is thin to non-existent throughout the site. The maximum recorded thickness of saprolite is 2.5 feet in boring no. 36 and one foot or less in boring nos. 39 and 51.

3.5 HYDROGEOLOGY

3.5.1 Regional Hydrogeology

The principal water-bearing unit in the Allied Fibers Frankford Plant area is the Farrington sand member. Greenman, et al. (1961) reported that the yields of 136 wells screened in the Farrington unit in the Pennsylvania Coastal Plain and nearby New Jersey ranged from 30 gallons per minute (gpm) to 1,350 gpm, with an average yield of 400 gpm. The general groundwater flow direction of the unit in Pennsylvania is believed to be toward the southeast (toward the Delaware River).

Where present, the continuity of the overlying Lower Clay member represents a confining bed that limits the movement of water between the Farrington member and the water-bearing zones above. The water-bearing properties of the Quaternary sediments in the plant vicinity are extremely variable. The reported yields of 61 wells completed in Pleistocene deposits range from 8 to 7,000 gpm (Greenman, et al., 1961).

The basement bedrock complex can be expected to reliably yield small to moderate quantities of groundwater. The reported yields of 74 wells completed in the bedrock average 65 gpm, with a range from one to 350 gpm (Weston, 1980). Exchange of groundwater between the bedrock and the overlying sediments is believed to be restricted by the residual saprolite immediately above the bedrock, where it is present.

3.5.2 Site Hydrogeology

3.5.2.1 Available Well Information

Three shallow monitoring wells (MW-101, MW-102, and MW-103) were installed during the RFI Phase I field work at the Allied Fibers Frankford Plant. The construction and condition of six recovery wells and five existing piezometers were also evaluated during this phase. The locations of all monitoring wells, recovery wells, and existing piezometers are shown on Figure 2-1.

Three monitoring wells were installed as part of the Phase I RFI. All three wells are screened through the shallow water-table surface. A summary of construction, completion, and elevation data for these wells is contained in Table 3-1. More specific installation and completion details, including backfill materials and borehole dimensions, are shown on the Monitoring Well Installation Sheets included in Appendix C.

Five existing piezometers, designated as P-1 through P-5, were located and evaluated (see Figure 2-1 for locations). Previous designations and summary of construction details obtained from the evaluation are contained in Table 3-1.

Six recovery wells exist at the Allied Fibers Frankford Plant. Recovery well nos. R-1, R-2, and R-3 are located in the caustic spill area of the site. Recovery well nos. R-4, R-5, and R-6 are located within the LNAPL layer (see Section 4.0). The locations of these six wells are shown in Figure 2-1.

Complete field evaluation measurements were taken in R-1, the inactive recovery well of the caustic spill area. The same measurements, with the exception of total depth, were taken in the active wells R-2 and R-3. The total depths of wells R-2 and R-3 were not measured to avoid interfering with the water-level probes or pumps. All three wells are constructed of galvanized-steel pipe or casing. Forty-eight evenly spaced 3/8-inch circular perforations are present around the circumference of the casing at regularly spaced three-inch-depth increments from the surface to the visible water level in each well. The remaining construction details are presented in Table 3-1.

Data for recovery wells R-4, R-5, and R-6 were obtained from the RFI Plan (NUS, 1991), from blueprints of the wells' construction provided by Allied, and from field measurements. The following paragraphs excerpted from the RFI Plan (NUS, 1991) summarize the completion and construction details of these recovery wells. Additional information is supplied in Table 3-1.

Recovery well R-4 was installed on June 27, 1984. It is located adjacent to Phenol Unit No. 2 (CP2) on Main Street west of Wakeling Street (see Figure 2.5). R-4 is 20 feet deep, with 15 feet of slotted 26-inch-diameter screen placed in a 36-inch borehole packed in Morie filter sand. When the groundwater reaches a predetermined level, a probe is tripped and pumping is initiated.

TABLE 3-1
CONSTRUCTION DETAILS OF EXISTING WELLS AND PIEZOMETERS
ALLIED FIBERS FRANKFORD PLANT
PHILADELPHIA, PENNSYLVANIA

Well or Piezometer Number	Date Installed	Previous Designation	Casing Material	Casing Inner Diameter (inches)	Well Completion	Total Depth (feet)	Reference Point and Elevation (feet MSL) for Water Level Measurements
PIEZOMETERS							
P-1	unknown	unknown	PVC	1.25	unknown	15.7	Top of Casing 14.49
P-2	January 1983	B-3	steel	2	unknown	16.7	Top of Casing 10.83
P-3	January 1983	B-1	steel	2	unknown	15.95	Top of Casing 10.81
P-4	January 1983	G-3	steel	2	unknown	14.2	Top of Casing 8.97
P-5	December 23, 1982	West Well	steel	2	unknown	8.7	Top of Casing 10.33
RECOVERY WELLS							
R-1	1983	R-1	galvanized steel	18	(1)	18.3	Ground(2) 9.71
R-2	1983	R-2	galvanized steel	18	(1)	unknown	Ground(2) 9.26
R-3	1983	R-3	galvanized steel	18	(1)	unknown	Ground(2) 9.11
R-4	June 27, 1984	R-4	galvanized steel	26	(1)	20	Ground(3) 11.35
R-5	June 17, 1985	R-5	concrete	48	(1)	16	Ground(3) 14.84
R-6	July 1990	R-6	unknown	48	(1)	13.5	Ground(3) 10.95
MONITORING WELLS							
MW-101	January 16, 1992	MW-101	stainless steel	2	screened(4) 5 to 15 feet	15	Top of Inner Casing 10.89
MW-102	January 17, 1992	MW-102	stainless steel	2	screened(4) 10 to 20 feet	20	Top of Inner Casing 16.11
MW-103	January 17, 1992	MW-103	stainless steel	2	screened(4) 5 to 15 feet	15	Top of Inner Casing 7.46

(1) Refer to text for description of well completion.

(2) Concrete surface adjacent to manhole cover on northern side.

(3) Top of steel manhole frame adjacent to northern side of manhole cover.

(4) Johnson 0.010 slot, two-inch inner diameter, stainless steel

Recovery well R-5 was installed on June 17, 1985. It is located on Wakeling Street adjacent to the CP2 tank farm. The R-5 well casing is 16 feet deep. Two lateral extensions set at 45-degree angles intersect the 58-inch-outside-diameter well casing. The lateral extensions are 10-inch-diameter polyvinyl chloride (PVC), Schedule 80 pipe, with 1/2-inch perforations on the top half of the pipe. The extensions are on a slope to facilitate flow to the well casing. When groundwater reaches a predetermined level, a probe is tripped and pumping is initiated.

Recovery well (R-6) was completed in July 1990. R-6 is located adjacent to CP2 on Main Street west of Wakeling Street. The R-6 well casing is 13 feet, six inches in total depth. Two lateral extensions (85 feet and 100 feet long) lie parallel to "M" sewer along Main Street and intersect the 48-inch-inside-diameter well casing. The lateral extensions are 10-inch-diameter PVC Schedule 80 pipe, with 1/2-inch perforations on the top half of the pipe. The laterals are on a 0.1-inch-per-foot slope to facilitate flow to the well casing. When the groundwater reaches a predetermined level, a probe is tripped and pumping initiated.

3.5.2.2 Shallow Groundwater

The shallow aquifer occurs within the upper sand and gravel lithologic unit in the northern portion of the facility, and it occurs within the fill deposits in the southern portion of the facility. Between these two areas, the shallow aquifer occurs within both the fill and the upper sand and gravel unit. Where the silt-clay unit is present, it is not expected to function as part of the shallow aquifer but rather as a confining unit at the base of the shallow aquifer. This is because the unit consists of well-sorted, very fine-grained material and is expected to have very low permeability.

The depth and elevation of the shallow water-table surface were measured in each of the three monitoring wells, the five piezometers, and recovery wells R-1, R-2, and R-3. All these measurements were taken on the same day within a time span of about 40 minutes. The results of these water-level and elevation measurements are summarized in Table 3-2. The groundwater elevations are plotted and contoured on Figure 3-8. The elevations of reference points for all wells and piezometers were surveyed with respect to USGS mean sea level datum (USGS MSL Datum = Allied Frankford Plant Datum + 6.071 feet; Philadelphia City Datum = Allied Frankford Plant Datum + 0.195 feet).

Site Name: Allied Fibers Frankford Plant
Project No.: 3814

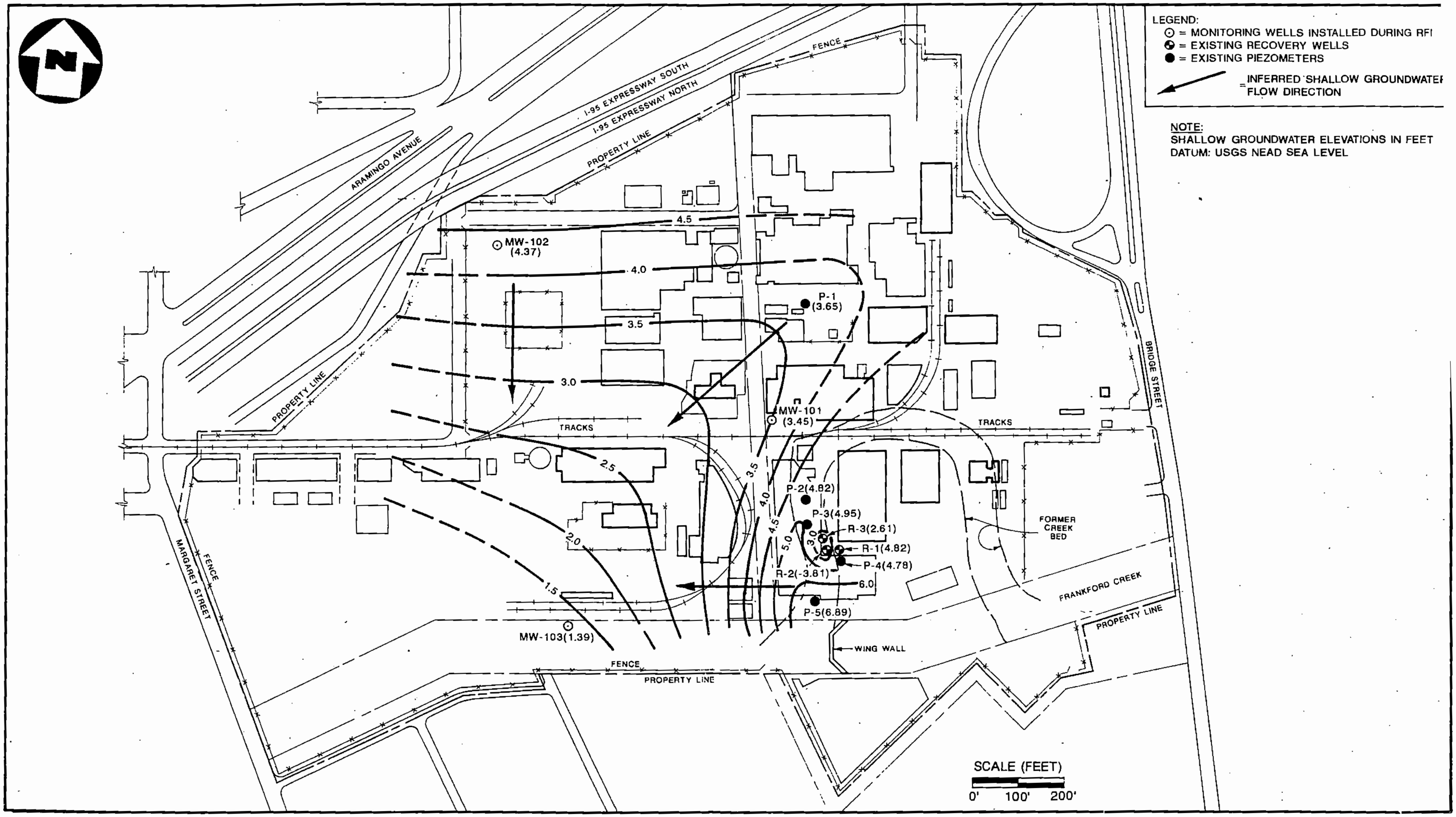
TABLE 3-2

GROUNDWATER LEVEL DATA SUMMARY

ALLIED FIBERS FRANKFORD PLANT

PHILADELPHIA, PENNSYLVANIA

Well or Piezometer Number	Water Level Measurement		Elevation of Reference Point (feet, MSL)	Water Level Depth Below Reference Point (feet)	Groundwater Elevation (feet, MSL)
	Date	Time			
MW-101	February 21, 1992	11:33 A.M.	10.89	7.44	3.45
MW-102	February 21, 1992	11:45 A.M.	16.11	11.74	4.371
MW-103	February 21, 1992	11:38 A.M.	7.46	6.07	1.39
P-1	February 21, 1992	11:51 A.M.	14.49	10.84	3.65
P-2	February 21, 1992	11:28 A.M.	10.83	6.01	4.82
P-3	February 21, 1992	11:26 A.M.	10.81	5.86	4.95
P-4	February 21, 1992	11:16 A.M.	8.97	4.19	4.78
P-5	February 21, 1992	11:13 A.M.	10.33	3.44	6.89
R-1	February 21, 1992	11:20 A.M.	9.71	4.89	4.82
R-2	February 21, 1992	11:22 A.M.	9.26	13.07	- 3.81
R-3	February 21, 1992	11:24 A.M.	9.11	6.50	2.61



SHALLOW GROUNDWATER ELEVATION MAP

ALLIED FIBERS FRANKFORD PLANT

FIGURE: 3-8

HALLIBURTON NUS Environmental Corporation

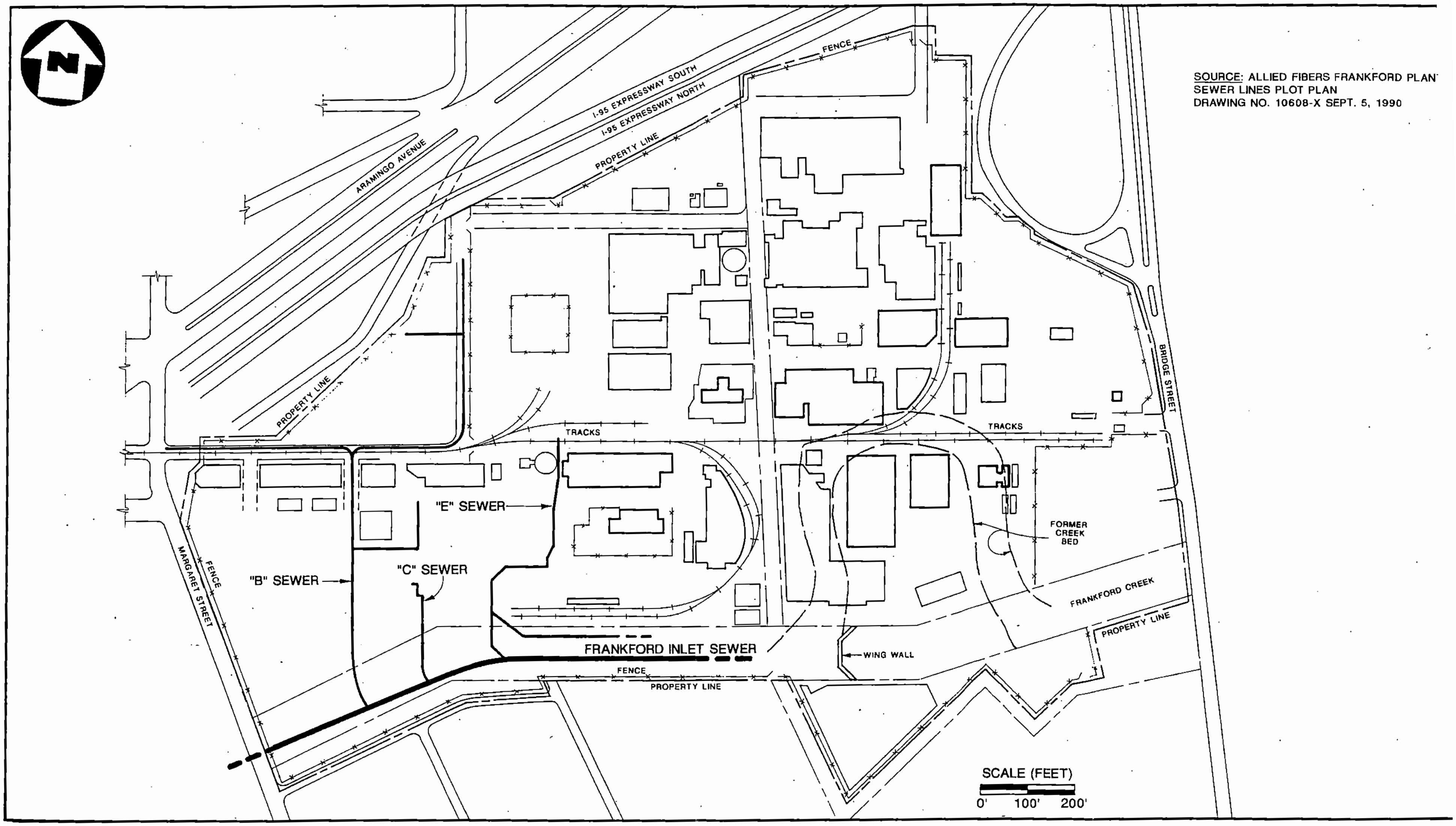
The groundwater elevation map provides coverage of only a portion of the site and should be considered an approximation in areas where control points are lacking or widely spaced. It is possible to infer the general direction of shallow groundwater flow in the areas where groundwater elevations are known. The direction of shallow groundwater flow should be perpendicular to the groundwater elevation contours in the direction of decreasing elevation.

Approximate groundwater flow directions can be predicted, using Figure 3-8. In the northwestern part of the facility, near MW-102, the direction of shallow groundwater flow is inferred to be generally toward the south. In the central and northeastern part of the facility, near Phenol Unit No. 2 and piezometer P-1, the shallow groundwater flow is inferred to be generally to the southwest. In the southeastern part of the facility, near Wakeling Street south of Main Street, the shallow groundwater flow direction is inferred to be toward the west.

Based on the limited data points available, the general shallow groundwater flow direction is toward the west or southwest. The areal extent of the LNAPL layer (see Section 4.0) is relatively consistent with the predicted shallow groundwater flow direction.

The southwestward flow of the shallow groundwater would not be expected under natural conditions. Rather, flow to the east/southeast (toward the Frankford Inlet and Delaware River) would be expected. The southwestward flow appears to be caused by man-made influences. Because there are no known groundwater withdrawal wells located immediately southwest of the Allied Fibers Frankford Plant, a plausible explanation for the southwestward flow is infiltration into sewer lines. Several sewer lines are present in the southwestern portion of the plant, including three Frankford Plant sewers and the two parallel city of Philadelphia sewers (see Figure 3-9). It is plausible that infiltration into on-site sewers is creating a significant cone of depression in the shallow groundwater unit.

The effect of the CP2 recovery wells (R-4, R-5, and R-6) on the shallow groundwater flow directions and elevations cannot be completely determined from the existing number and distribution of wells and piezometers. They do not appear to be creating a significant cone of depression, however. The caustic spill recovery wells create a significant drawdown of the shallow water table; however, nearby piezometers indicate that the effect is very localized. Groundwater elevations and flow directions throughout the remainder of the site, the effect of tidal influences from the Frankford Inlet on the shallow aquifer, the effects of on-site and off-site sewer lines (if any), and the determination of more detailed shallow groundwater flow patterns beneath the facility cannot be more accurately predicted at this point and will require further hydrogeologic investigation.



LOCATION OF PRINCIPAL SEWER LINES IN SOUTHWESTERN PORTION OF SITE

ALLIED FIBERS FRANKFORD PLANT

FIGURE: 3-9

HALLIBURTON NUS Environmental Corporation

Monitoring wells MW-101, MW-102, and MW-103 have different lithologic settings within the shallow aquifer at the Frankford facility. In MW-102, located in the northern part of the site, fill deposits extend from the surface to a depth of 4 or 5 feet, below which the upper sand and gravel unit extends to the total depth of about 20 feet. The depth to groundwater is 11.74 feet; thus, the shallow groundwater unit is entirely within the upper sand and gravel unit at the MW-102 location. At the MW-101 location, in the central part of the site, the fill deposits extend from the surface to a depth of about 11 feet. The upper sand and gravel unit extends from a depth of 11 feet to the total depth of about 15 feet. The depth to groundwater measured in MW-101 was 7.44 feet; thus, the shallow groundwater unit occurs within both the fill deposits and the upper sand and gravel unit at this location. At the MW-103 location, in the southern part of the site, the fill deposits extend from the surface to total depth at about 15 feet. The silt-clay unit directly underlies the fill deposits in this area. The depth to groundwater was measured at 6.07 feet; thus, the shallow groundwater unit occurs entirely within the fill deposits at the MW-103 location.

In situ hydraulic conductivity measurements (rising-head slug tests with automatic data loggers) were performed in each of the three monitoring wells to obtain a record of water-level recovery versus time. Hydraulic conductivities were calculated from these data with the AQTESOLV program (Geraghty and Miller, 1989) using the Bouwer-Rice method for unconfined aquifers. Raw data, data plots, and calculations for these determinations are contained in Appendix D. The hydraulic conductivity results are summarized below.

Well Number	Hydraulic Conductivity	
	cm/sec	feet per day
MW-101	1.4×10^{-2}	40
MW-102	8.7×10^{-2}	247
MW-103	1.7×10^{-3}	5

The hydraulic conductivity values obtained are relatively high and are consistent with the fairly coarse and unconsolidated types of sediments in which the wells are completed. The results indicate that hydraulic conductivity and permeability are greatest in the northern part of the shallow aquifer where the aquifer is composed entirely of the upper sand and gravel unit (MW-102). The measured hydraulic conductivity and permeability of the shallow aquifer decrease by approximately one order of magnitude southward as the fill deposits constitute progressively greater percentages of the shallow aquifer (MW-101 and MW-103). This decrease may be attributed to the greater percentage of fine-grained material in the fill deposits relative to the upper sand and gravel unit.

3.5.2.4 Hydrology of Deeper Aquifers

Specific hydrologic information is not available for the deeper aquifers or geologic units at the Allied Fibers Frankford Plant. However, some assumptions can be made based on the local and regional hydrogeologic information and on the site geologic information.

The silt-clay unit at the site is expected to function as a confining layer rather than as an aquifer. Visual descriptions, grain size distribution analyses, and available geologic references indicate that this unit has low permeability and that the movement of groundwater across or within the unit is very limited. When present beneath the shallow aquifer, the silt-clay unit is expected to act as a barrier to the downward movement of groundwater from the shallow aquifer to any deeper aquifers that may be present.

The lower sand and gravel unit at the Allied Fibers Frankford Plant is expected to function as an aquifer with good water-bearing capabilities based on the coarse, unconsolidated nature of the deposits. If this is the Farrington Sand member of the Raritan Formation, as discussed in Section 3.4.2.2, then its properties and importance as an aquifer are already well documented. In all documented occurrences at the Allied Fibers Frankford Plant, the lower sand and gravel unit is overlain by relatively thick deposits of the silt-clay unit. In such cases, the silt-clay unit is expected to act as an upper confining layer to the lower sand and gravel. This would greatly restrict the degree of hydrologic interconnection between the shallow aquifer and the lower sand and gravel. If the lower sand and gravel unit is overlain by the silt-clay unit throughout the Allied Fibers Frankford Plant, it is expected to receive little or no recharge from the shallow aquifer at the site.

The aquifer characteristics of the bedrock underlying the site are unknown. The bedrock is in contact with the upper sand and gravel of the shallow aquifer, the silt-clay unit, and the lower sand and gravel unit in different areas throughout the site. In many cases, the exchange of groundwater between the bedrock and overlying sedimentary aquifers is restricted by the saprolite layer immediately overlying the bedrock. However, the saprolite layer is interpreted to be thin or possibly nonexistent at the Allied Fibers Frankford Plant, suggesting that a greater degree of interconnection is possible. The actual degree of hydrologic interconnection between the bedrock and overlying sedimentary aquifers at the Frankford facility cannot be estimated from the available data.

3.6 POTABLE WATER SUPPLY

Residents within the areas of Pennsylvania surrounding the Frankford facility obtain drinking water from the Philadelphia Water Department (PWD). PWD obtains water from two intakes on the Schuylkill River and one intake on the Delaware River. The PWD Torresdale intake is located in the tidally influenced portion of the Delaware River at river mile 110.5, approximately 5.5 miles upstream of the mouth of the Frankford Inlet. No surface water used for drinking water supplies have been identified downstream of the Allied Fibers Frankford Plant (NUS, 1989 and NUS, 1991).

Records are available for 70 wells that have been installed on the Pennsylvania side of the Delaware River within approximately one mile of the Allied Fibers Frankford Plant (Paulachok, et al., 1984). Approximately 40 percent of these wells were reportedly completed in schist or gneiss bedrock and another 40 percent were reportedly completed in Pleistocene sand and gravel deposits. The remaining 20 percent were reportedly completed in the lower sand unit of the Potomac - Raritan - Magothy aquifer system. In this area of the Pennsylvania Coastal Plain, the lower sand unit of the Potomac - Raritan - Magothy aquifer system is equivalent to the Farrington sand member of the Raritan Formation (Greenman, et al., 1961 and Paulachok, et al., 1984). Of the 70 recorded wells, two were reportedly used for industrial water supply withdrawals, 14 were reportedly used as observation wells, and the rest were reported to be either unused or destroyed (Paulachok, et al., 1984). The current uses of these wells, if any, were not verified during the Phase I RFI. The current status of existing wells within the vicinity of the Allied Frankford Plant should be confirmed during the Phase II RFI.

Groundwater is used as a source of drinking water in New Jersey on the opposite side of the Delaware River. The Camden City Water Department (CCWD) maintains several municipal supply wells in the area approximately 1.4 miles or more southeast of the facility. The New Jersey Water Company (NJWC) supplies water in the Palmyra area and also uses wells. Both CCWD wells and NJWC wells produce from the Magothy Raritan aquifer system (Weston, 1980; NUS, 1989; and NUS, 1991).

3.7 POPULATION AND LAND USE

The Allied Fibers Frankford Plant lies in the Bridesburg section of Philadelphia, Pennsylvania. Immediately adjoining the facility to the south is a densely populated residential area. A mixed residential and industrial area lies across Interstate 95 north of the facility. The TIP Trailer sales lot is located immediately west of the facility. The Arsenal Business Center (formerly Frankford Arsenal) is located east of the plant and consists of professional offices and warehouses (NUS, 1989). The Rohm and Haas Delaware Valley, Incorporated Philadelphia chemical plant is located southeast of the facility.

3.8 ECOLOGY

The site is an urban industrial area with restricted access that supports very little vegetation. The only ecological receptors identified are aquatic species in the Frankford Inlet (if any) and the Delaware River.

The shortnose sturgeon (Acipenser brevirostrum) can be found in the Delaware River. This fish is listed by the Pennsylvania Fish Commission and the United States Fish and Wildlife Service as endangered (Shiffer, 1983). As stated in the Allied Fibers Frankford Plant Part B Permit application (Allied, 1985), the site was not categorized as located in the corridor of a stream or a river designated as a national or state wild, scenic, recreational or modified recreational river in accordance with the National Wild and Scenic Rivers Act of 1968 or the Pennsylvania Scenic Rivers Act. Based on available information, the site is not located within one mile of a 1A priority for study stream or river under PA DER's determination of a state wild, scenic, recreational, or modified recreational river (Allied, 1985).

A report has been prepared by the Delaware River Basin Commission (DRBC) based on a fish population study done by the Pennsylvania Fish Commission during the summers of 1984 to 1986 on Zones 2, 3, and 4 of the Delaware River. Thirty-six fish species were reported in Zone 3, and 53 species were reported for all three zones. Among the Zone 3 species were blueback herring, white perch, silvery minnow, spottail shiner, banded killifish, pumpkinseed sunfish, inland silverside, alewife, mummichog, and channel catfish (DRBC, 1987). A subsequent health and contamination study was conducted on the catfish family and white perch. It was concluded that the fish were generally healthy, and observed pathologic conditions could not be correlated to toxicants in the river. The fish were reportedly affected by some physical stresses such as seasonal high water temperature and the onset of spawning. Accumulation of PCBs, DDT metabolites (below Food and Drug Administration Action Levels), and chlordane was reported. Accumulation of some metals, such as arsenic, was also reported. Mainly because of the PCBs, the study concluded that the edibility of some fish species could be questionable (DRBC, 1988).

A complete list of New Jersey and Pennsylvania water quality standards for this zone was presented in Appendix B of the RFI Plan (NUS, 1991). Water quality standards, including federal AWQCs, for site contaminants are summarized in Table 2-5. The New Jersey standards also refer to drinking water standards; the potentially applicable MCLs are listed in Table 2-4.

4.0 STUDY AREA NO. 1

4.1 DESCRIPTION

Study Area No. 1 includes SWMU No. 46, the phenol water system, and AOC-1, the groundwater recovery wells (LNAPL layer). The phenol water system included underground piping, trenches, and sumps and contained phenol water, rinse waters, condensates, decanter water, and runoff waters. An LNAPL (cumene) plume has been detected at the site and was believed to have originated from a leak in the phenol water system at the CP2 phenolic waste water sump (NUS, 1991). This leak was repaired in 1983, and a conversion of this system from underground to above-ground piping has been implemented.

Five groundwater recovery wells pump groundwater from the CP2 process area and the caustic spill area. The caustic recovery wells were installed in 1983 to recover approximately 11,000 gallons of 50 percent sodium hydroxide (NaOH) that leaked into the ground in December 1982 (NUS, 1991; Kearney, 1987). As of April 1991, an estimated 90 percent of the released caustic had been recovered (Ferguson, 1992).

Detailed historical information on Study Area No. 1 (i.e., specific dates, well measurements) can be found in the RFI Plan, Volume I (NUS, 1991).

4.2 INVESTIGATION

4.2.1 Previous Investigations

Measurements of the LNAPL thickness beneath the CP2 area were taken by Allied in May 1982 and January 1983.

Two rounds of samples were collected from the LNAPL, in 1982 and 1983. These samples were analyzed for acetone, phenol, cumene, AMS, AMS dimers, cumene hydroperoxide, acetophenone, dimethylphenylcarbinol, ethylbenzene, naphthalene, and thionaphthene.

Recovery well samples were obtained in 1990 and analyzed for VOAs (by EPA Methods 8240 and 1624-C), BNAs (by EPA Methods 8270 and 1625-C), pesticides/PCBs (by EPA Method 8080), TCLP metals (by EPA Method 6020), and herbicides (by EPA Method 8150).

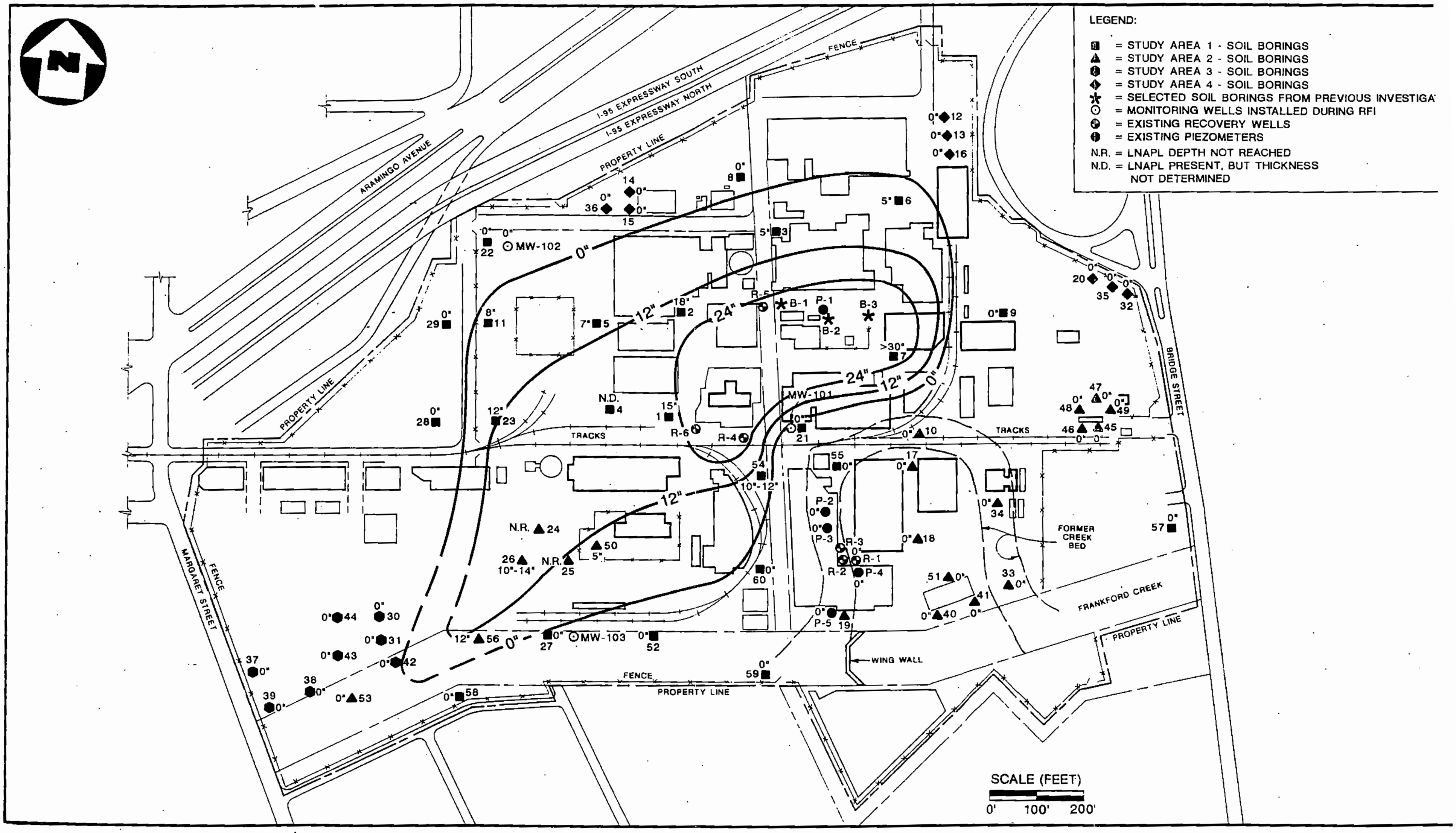


FIGURE: 4-1

ESTIMATED THICKNESS OF LNAPL LAYER

ALLIED FIBERS FRANKFORD PLANT

HALLIBURTON NU
Environmental Corporati

4.2.2 Phase I Investigation

Twenty-three soil borings were completed throughout the site to determine the extent of the LNAPL plume. In addition, borings from other study areas were used to delineate the LNAPL extent. LNAPL presence and thickness were determined using visual observations, photoionization detector (PID) readings, and a hydrocarbon-water interface probe.

Three shallow groundwater monitoring wells (MW-101, MW-102, and MW-103) were also installed. These wells are described in Section 3.5. Groundwater samples taken from these monitoring wells were analyzed for the following parameters:

- Target Compound List (TCL) VOA
- TCL BNA
- Cumene and AMS
- TCL Pesticides/PCBs
- Dioxins (screen)
- Total Organic Carbon (TOC)
- Target Analyte List (TAL) Total Metals
- TAL Dissolved Metals

Part of the Phase I effort involved validation of recovery well data that were obtained in 1990 and analyzed for VOAs (by EPA Method 8240), BNAs (by EPA Method 8270), pesticides/PCBs, TCLP metals, and herbicides.

4.3 SITE CHARACTERISTICS

For the purposes of this discussion, the portion of the Allied Fibers Frankford Plant covered by Study Area No. 1 is roughly defined by the area in which the LNAPL layer is present (see Figure 4-1) and by the distribution of soil borings drilled to define the layer. Study Area No. 1 is divided into northern and southern sections based on geologic differences. The northern section of Study Area No. 1 occurs north of Main Street and is roughly rectangular in shape. The northwestern, northeastern, southeastern, and southwestern corners are approximately coincident with soil boring location nos. 22, 6, 10, and 28, respectively. The southern section of Study Area No. 1 occurs south of Main Street and west of Wakeling Street. It extends southward into the filled channel of the former Frankford Creek but not to the southern property boundary and extends westward to the location of soil boring nos. 30, 31, and 42.

4.3.1 Geology

4.3.1.1 Northern Section

The fill deposits in the northern section of Study Area No. 1 consist primarily of sand, silt, clay, and gravel, with considerable amounts of brick, rock and concrete fragments, and wood. A tar-like residue was found in boring nos. 5 and 11; and in boring no. 10 to the southeast within the filled creekbed meander (see Section 5.3.1). Coal is present in boring nos. 6 and 9 in the northeastern part of the area, and ashy material is present in boring nos. 9, 10, and 21 in the southeastern part of the area. Miscellaneous fill materials, including steel-reinforcing rods and wire, glass and shell fragments, and granite cobblestones, occur sporadically throughout the area. The boring for MW-101 encountered an interval about three to four feet thick that contained a considerable proportion of glass fragments ranging up to one inch or more in size. Most of the northern section of Study Area No. 1 is covered by pavement, buildings, or plant facilities (see Figure 3-6). The unpaved surfaces are generally covered by a layer of crushed-stone gravel.

The fill deposits generally range from two to seven feet thick throughout most of the northern section of Study Area No. 1 and from about 10 feet to more than 20 feet in the extreme southeastern portion of the northern section (see Figure 3-5). The fill thickness gradually increases from northwest to southeast throughout most of the area and exhibits a more rapid increase near the filled creekbed meander in the extreme southeastern part of the section.

All soil borings in the northern section of Study Area No. 1 that completely penetrate the fill deposits encounter sediments of the upper sand and gravel lithologic unit. In the northwestern area near boring no. 36, the upper sand and gravel unit extends downward to the saprolite and bedrock at an approximate depth of 27.5 feet. The silt-clay and the lower sand and gravel units were not identified here. In the central though southeastern areas of the northern section of Study Area No. 1, the upper sand and gravel unit is underlain by the silt-clay unit at depths of approximately 25 feet. The silt-clay unit in the area of soil boring B-1 is underlain directly by saprolite and bedrock (Woodward-Clyde, 1982). The lower sand and gravel lithologic unit may be present farther to the southeast within Study Area No. 1; however, this cannot be determined from the available data.

4.3.1.2 Southern Section

The fill deposits in the southern section of Study Area No. 1 consist primarily of sand, silt, clay, and gravel; and fragments of brick, rock, and concrete, wood, ash, ashy material, and coal. Unidentified black tarry substances and black tarry sludge-like materials occur within the fill material throughout this area. Approximately one-half of the southern section of Study Area No. 1 is covered by paved surfaces, buildings, or plant facilities (see Figure 3-6). The remaining portions are covered by a layer of crushed-stone gravel.

The fill deposits in the southern section of Study Area No. 1 range in thickness from approximately five feet in the northwestern part to 20 feet or more in the southern and eastern parts (see Figure 3-5). The fill thickness increases gradually to the south and east throughout most of the section. It increases more rapidly within the filled creekbed of the former Frankford Creek along the southern and eastern boundaries of the section.

The available soil boring information indicates that the upper sand and gravel lithologic unit is absent or thin throughout most of the southern section of Study Area No. 1. Some sandy deposits are present within the former creekbed areas, and significant thicknesses of the upper sand and gravel may be present near the boundary between the northern and southern sections of Study Area No. 1 where no soil borings were drilled. Most of the soil borings that completely penetrate the fill deposits encounter the silt-clay lithologic unit directly underlying the fill. The known distribution of the silt-clay deposits is shown in Figure 3-7. The general arrangement of the geologic units within the southernmost portion of Study Area No. 1 is illustrated by cross-section B-B' (see Figure 3-4).

Approximately five to six feet of the lower sand and gravel unit is interpreted to be present underlying the silt-clay unit and overlying the saprolite and bedrock in the southern portion of Study Area No. 1. The complete distribution of the lower sand and gravel unit within this area is not known. Saprolite and bedrock are expected to occur at an approximate depth of 40 feet below either the silt-clay or the lower sand and gravel unit.

4.3.2 Hydrogeology

The shallow aquifer within Study Area No. 1 is composed of the upper sand and gravel unit and the fill deposits. In the northernmost part of the area, the aquifer consists entirely of the upper sand and gravel. In the southernmost part of the area, it consists entirely of the fill deposits. In between, the shallow aquifer consists of varying proportions of each of these units. The depth to groundwater is about 12 feet below the surface in the northern part of the study area and becomes gradually less toward the southern part, where it is approximately four to six feet below the surface. The shallow aquifer within Study Area No. 1 has relatively high hydraulic conductivity and permeability. These values are greatest in areas where the aquifer consists entirely of the upper sand and gravel and are less by approximately one order of magnitude where the aquifer consists entirely of fill deposits. Additional discussions and information concerning the shallow groundwater and hydraulic conductivities at the Allied Fibers Frankford Plant are found in Section 3.5.

Figure 3-8 is a map of shallow groundwater elevations. The inferred directions of shallow groundwater flow based on the water-elevation contours are also shown on this figure. The shape and extent of the LNAPL layer (see Figure 4-1), which occurs on the top of the shallow groundwater surface, are consistent with the predicted shallow groundwater flow directions. In general, the shallow groundwater flow direction ranges from southward in the northwestern area through southwestward in the northeastern area through westward in the southeastern area. The groundwater elevations and predicted flow directions indicate a probable groundwater discharge point located near the southwestern corner of the plant. The most plausible mechanism for discharge of the shallow groundwater in this area is infiltration into underground sewer lines. The effects of the cumene recovery wells on shallow groundwater elevations and flow directions are not believed to be significant, based on the available data (i.e., a large cone of depression was not detected).

In areas where the silt-clay unit underlies the upper sand and gravel or fill deposits, it is expected to act as a lower confining unit to the shallow aquifer, limiting the downward migration of groundwater to deeper aquifers.

The degree of interconnection between the shallow aquifer and the underlying bedrock aquifer in the northwestern part of the study area is unknown. It is not possible to determine from the available information whether or not the shallow aquifer has any interconnection with the lower sand and gravel unit within the study area.

4.4 NATURE AND EXTENT OF CONTAMINATION

4.4.1 Soil Borings/LNAPL

The extent of the LNAPL plume as identified in the Phase I soil borings can be seen on Figure 4-1.

An LNAPL layer composed primarily of cumene occurs at the top of the shallow groundwater surface beneath a portion of the Allied Fibers Frankford Plant. The soil boring program for Study Area No. 1 was implemented to define the approximate thickness and extent of this LNAPL layer. The presence or absence of the LNAPL layer and its thickness at a given soil boring location was determined mainly by visual observations of continuous soil samples from the unsaturated through saturated zones. The areal extent and estimated thickness of the LNAPL layer shown in Figure 4-1 can be used to calculate rough estimates of the total LNAPL volume within the layer at the Frankford Plant (Appendix E).

The total area of the LNAPL layer shown in Figure 4-1 is approximately 720,000 square feet or 17 acres. The available soil boring data indicate that the LNAPL layer occurs entirely within the plant boundaries. The documented thickness of the layer ranges from zero inches, where no LNAPL was found, to about 30 inches in boring no. 7.

Scientific literature indicates that only a fraction of the pore spaces within the sediments containing LNAPL layers are actually saturated by LNAPL. The upper and lower interfaces of LNAPL layers are zones of transition between zero, or very low, LNAPL saturation and the maximum LNAPL saturation that occurs somewhere within the middle of the layer. The difference between the total liquid saturation and the LNAPL saturation represents the residual water saturation. The relative proportions of water saturation and LNAPL saturation within the total liquid saturation can vary greatly with respect to the grain size distribution of the saturated soils or sediments occupied by LNAPL layers (Lenhard and Parker, 1990; Farr, et al., 1990).

Predicted water and total liquid saturations and distributions using the van Genuchten and the Brooks-Corey models for LNAPL layers in two different sandy soil types are presented in "Estimation of Free Hydrocarbon Volume from Fluid Levels in Monitoring Wells" by Lenhard and Parker (1990). The maximum LNAPL saturation is approximately 30 percent for layers with thicknesses similar to the layer at the Frankford Plant (about 30 inches or 75 centimeters). Based on grain-size distribution analyses, the two example soil types are similar in composition to the upper sand and gravel unit at the facility. The range of porosities given for mixed, or poorly saturated, sand and gravel is 20 to 35 percent (Fetter, 1988). This description is characteristic of much of the upper sand and gravel unit at the Allied Fibers Frankford Plant. Therefore, the maximum porosity saturated by LNAPL at the Allied Fibers Frankford Plant is estimated to be approximately 10.5 percent (maximum total porosity of 35 percent times maximum LNAPL saturation of 30 percent).

The maximum estimated LNAPL volume within the layer at the Allied plant is calculated to be approximately 700,000 gallons using the areas and thicknesses from Figure 4-1 and the maximum LNAPL saturated porosity derived above.

More accurate estimates of the total LNAPL volume within the layer at the Allied Fibers Frankford Plant must reflect the fact that LNAPL-saturated porosities decrease with decreasing layer thickness from the maximum values. LNAPL saturation values versus saturated thickness were determined for the two similar soils described in Lenhard and Parker (1990) using the van Genuchten model. The LNAPL volumes contained in the three contoured areas of the LNAPL layer have been estimated using these saturation values and a total porosity of 35 percent for the sediments. The range of the LNAPL volume within the layer at the Frankford Plant was estimated to be from 200,000 to 500,000 gallons using these porosities and the areas and thicknesses from Figure 4-1. The calculations are contained in Appendix E.

The actual volume of LNAPL within the layer may be less than the estimated values because the estimations do not account for the expected decreased LNAPL saturation near the upper interface of the layer. The LNAPL volume within the layer may also be less if the total porosity of the upper sand and gravel unit and fill deposits containing the LNAPL layer are less than 35 percent. It is not possible to determine the effects that the grain size distribution of the LNAPL-bearing fill and sediments have upon LNAPL saturation values and total LNAPL volumes with the available data.

The data indicate that the volume of LNAPL beneath the site does not appear to have been significantly reduced by the groundwater recovery program conducted since 1984.

Measurements of the LNAPL thickness beneath the CP2 area were taken by Allied in May 1982 and January 1983. Measurement points are shown on Figure 4-2. These measurements were as follows:

LNAPL THICKNESS (inches)

Date	Well			
	B1A	B2	B3	B4
5/26/82	42	sheen	37	15
1/27/83	15	3	>30	2

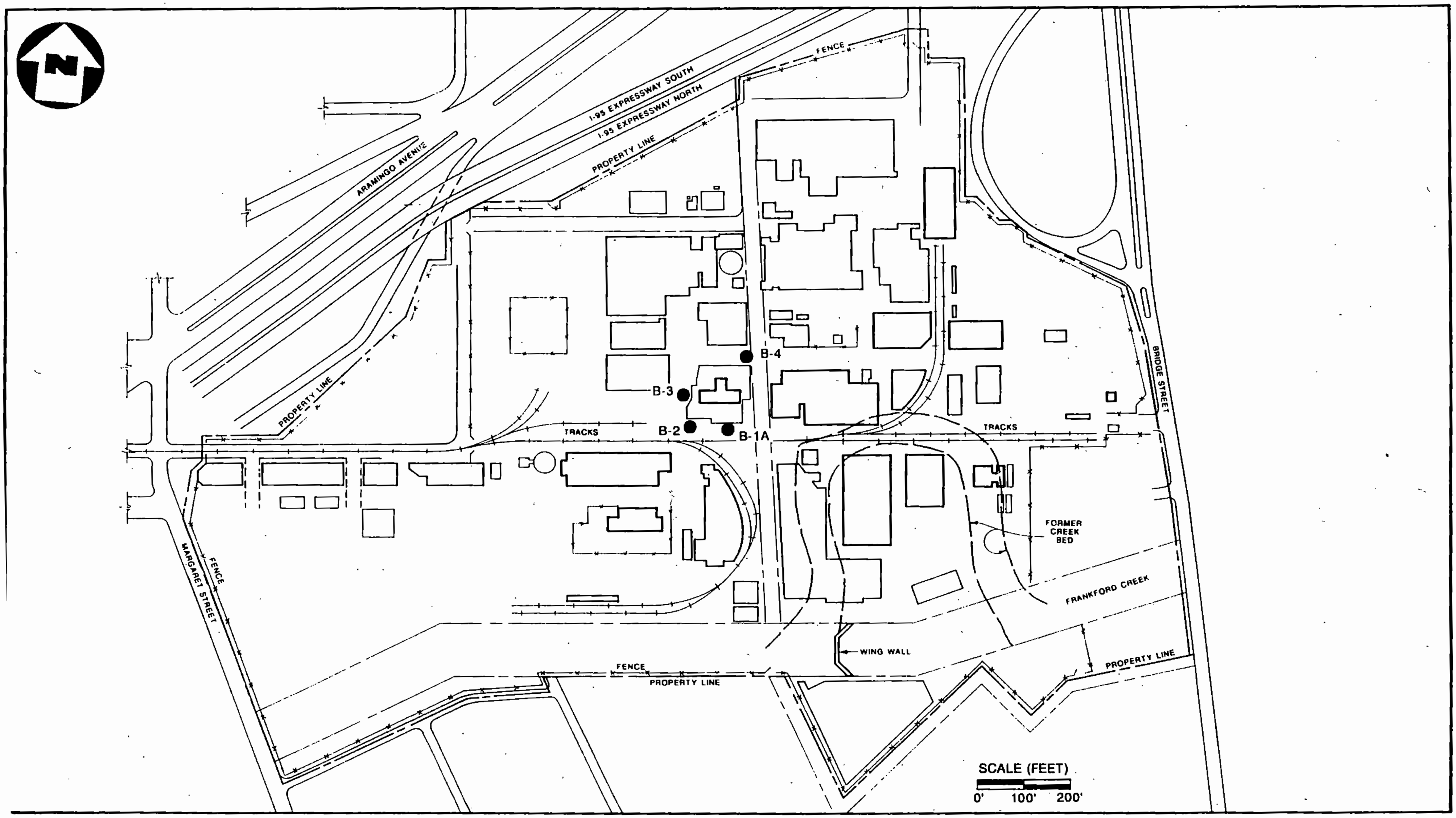
The measured LNAPL thicknesses are probably not representative of subsurface conditions because the measurements were taken from two-inch-diameter wells (Lenhard and Parker, 1990; Farr et al., 1990; Kemblowski and Chiang, 1990).

Two rounds of samples were collected by Allied from the LNAPL, in 1982 and 1983. Results from these analyses are presented in Table 4-1. The LNAPL consists primarily of cumene. These analyses were not performed using EPA-approved methods. Therefore, the data should be considered semi-quantitative (NUS, 1991). Visual and odor observations made during field activities for Phase I confirmed that the LNAPL is primarily cumene.

Naphthalene odors were also reported during Phase I boring activities throughout the area in which LNAPL was detected.

4.4.2 Groundwater Data

Pacific Analytical analyzed grab samples collected from recovery wells R2, R3, R5, and R6 on September 28, 1990, using EPA Methods 8240 (VOAs), 8270 (BNAs), 8080 (pesticide/PCBs), 6020 (metals), and 8150 (herbicides). These validated data, including TICs, are presented in full in Appendix A. The data are summarized in Table 4-2. [Note: The September 28, 1990 samples were analyzed for only a limited number of target analytes (see Appendix A).]



LOCATION OF FORMER WELLS NEAR CP-2 PROCESS AREA
ALLIED FIBERS FRANKFORD PLANT

FIGURE 4-2

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Site Name: Allied Fibers Frankford Plant
Project No.: 3814

TABLE 4-1

ANALYTICAL RESULTS FROM UNIT 2 AREA LNAPL PHASE SAMPLES
ALLIED FIBERS FRANKFORD PLANT
PHILADELPHIA, PENNSYLVANIA

MAY 26, 1982

Organic Components	Well B1A	Well B2	Well B3	Well B4	Well B2 (Water Phase)
Acetone, Wt. %	---	---	---	---	0.20
Phenol, Wt. %	---	0.01	0.85	---	0.03
Dimethylphenylcarbinol (DMPC), Wt. %	0.10	0.08	---	3.00	0.04
Acetophenone, Wt. %	2.70	0.17	0.38	1.46	0.01
Cumene Hydroperoxide, Wt. %	---	---	---	---	---
Alpha Methylstyrene (AMS), Wt. %	0.31	2.32	6.26	0.11	0.01
Cumene, Wt. %	96.11	97.05	92.15	87.63	0.06
AMS Dimers, Wt. %	0.27	0.07	0.17	---	---
Total, Wt. %	99.49	99.70	99.81	92.20	0.35

MARCH 23, 1983

Organic Components	Well B1A	Well B2	Well B3	Well B4
Acetone, Wt. %	ND	ND	ND	ND
Benzene, Wt. %	ND	ND	ND	ND
Ethylbenzene, Wt. %	0.02	0.07	0.02	0.02
Cumene, Wt. %	61.70	86.28	84.16	44.56
Phenol, Wt. %	0.02	0.15	0.27	ND
AMS, Wt. %	0.15	1.57	7.65	0.17
Acetophenone, Wt. %	0.35	0.06	0.32	0.38
DMPC, Wt. %	0.14	0.05	0.15	0.70
Naphthalene, Wt. %	0.10	0.58	0.11	ND
Thionaphthene, Wt. %	ND	ND	ND	ND
Unknown, Wt. %	Balance	Balance	Balance	Balance
Sulfur, ppm	81	376	89	NA

ND - Not detected
NA - Not analyzed - insufficient sample
Source: Allied Frankford files

Site Name: Allied Fibers Frankford Plant
Project No.: 3814

TABLE 4-2
SEPTEMBER 28, 1990 RECOVERY WELL DATA
ALLIED FIBERS FRANKFORD PLANT
PHILADELPHIA, PENNSYLVANIA

Chemical	R2 (ug/l) (9/28/90)	R3 (ug/l) (9/28/90)	R5 (ug/l) (9/28/90)	R6 (ug/l) (9/28/90)	MCL
Methylene Chloride	ND	ND	3,600 L	ND	
Acetone	2,300 B	7,300 B	52,000 L	32,000 L	
2-Butanone	ND	ND	1,400 L	ND	
Benzene	ND	1,600 L	6,500	36,000 L	
Toluene	ND	740 L	1,600 L	14,000 L	
Ethylbenzene	ND	ND	550 L	1,200 L	
Styrene	ND	ND	ND	680 L	
Xylenes	ND	ND	870 L	5,300 L	
2-Methylphenol	140 L	5,300 L	ND	570 L	
4-Methylphenol	390 L	19,000 L	ND	1,700 L	
Pyridine	31 L	510 L	ND	ND	
2,4,5-T	ND	ND	1.7	0.6 J	
Arsenic	80.4	371	12.5	ND	50
Barium	121	23.7	110	178	100
Cadmium	ND	ND	0.18	ND	
Chromium	103	22.9	7.23	650	50
Lead	1.97	149	62.6	63.2	50
Mercury	ND	72.0	ND	ND	2

B = Attributed to blank contamination
L = Biased low
ND = Not detected
J = Estimated

Pacific Analytical analyzed several grab samples collected from recovery wells R5 and R6 on October 2, 1990, using Method 1624-C for volatile compounds and Method 1625-C for semivolatile compounds. These methods do not require the use of surrogate spike compounds or internal standards because isotopes of every target compound are spiked into each sample prior to extraction and/or analysis, and all quantitations are based on the recoveries of the isotopic compounds. These methods are contained in the Federal Register, Vol. 49, No. 209, Friday, October 26, 1984.

Validation of the October 2, 1990 sample data was limited to ensuring that the data were complete for all analyses of samples from R5 and R6. The laboratory did not supply any sample-specific raw data (mass spectra or quantitation reports); calibration data were supplied. Based on the fact that these methods are at least as accurate as EPA Methods 8240 and 8270, and possibly more accurate, quantitations should be considered reliable as reported. Because no qualitative raw data were available for review, no conclusions regarding compound identification can be made. The Method 1624/1625 data are presented on Tables 4-3 and 4-4.

Results qualified with a "B" (attributed to blank contamination) or an "R" (unreliable) are not reported in Tables 4-2, 4-3, and 4-4 unless there were also positive results for that chemical.

Most of the compounds detected in these wells are associated with site process operations, including cresols, acetone, benzene, substituted benzenes, styrene, anthracene, biphenyl, acetophenone, naphthylamines, and pyridine. Among the tentatively identified compounds (TICs) detected in the recovery wells are alkylbenzenes, phenol, substituted phenols, methylnaphthalene, benzoic acid, and substituted quinolines, which may be associated with the site's historical activities (NUS, 1991).

The three monitoring wells sampled during Phase I were MW-101 (central portion of site), MW-102 (northwest portion of site), and MW-103 (duplicate; southern portion of site) (see Figure 2-1). LNAPL was not detected in any of the three monitoring wells. The complete monitoring well data set, including TICs, is presented in full in Appendix A. Table 4-5 summarizes positive detections. Results qualified with a "B" (attributed to blank contamination) or an "R" (unreliable) are not reported on these tables unless there were also positive results for that chemical.

Only tentatively identified PAHs were detected in the MW-102 sample. This well was located in a part of the site in which significant contamination was not reported.

TABLE 4-3

**OCTOBER 2, 1990 RECOVERY WELL DATA
VOLATILE ORGANIC COMPOUNDS
ALLIED FIBERS FRANKFORD PLANT
PHILADELPHIA, PENNSYLVANIA**

Chemical	R5 (ug/l) 0900	R5 (ug/l) 1500	R5 (ug/l) 2100	R5 (ug/l) 0300	R6 (ug/l) 0900	R6 (ug/l) 1500	R6 (ug/l) 2100	R6 (ug/l) 0300
Methyl Ethyl Ketone (2-Butanone)	600 J	350 J	450 J	900 J	460 J	270 J	340 J	530 J
1,2-Dichloroethane	11 J	11 J	11 J	11 J	13 J	12 J	12 J	11 J
Benzene	8,500	8,800	7,400	44,000	45,000 J	66,000	12,000	8,500
Toluene	1,700	1,700	1,500	13,000	13,000	16,000	4,300 J	1,700
Ethylbenzene	780	740	770	1,400 J	1,800	1,900 J	2,400 J	770
m-Xylene	240	400 J	340 J	2,700 J	3,800	3,900 J	14,000	270 J
o, p-Xylene	130	240 J	190 J	1,500 J	1,900	2,000 J	7,400	160 J
Trans-1,2-Dichloroethene	ND	ND	ND	11	12 J	13	12	ND
Carbon Disulfide	ND	ND	ND	ND	9.0 J	6.6 J	5.3 J	ND
Tetrachloroethene	ND	ND	ND	ND	ND	11 J	8.9 J	ND
Acetone	19,000 B	32,000 R	110,000 J	42,000 B	22,000 B	23,000 B	39,000 B	21,000 B
Methylene Chloride	ND	ND	ND	ND	ND	ND	2.7	ND

R = Unreliable
ND = Not detected
B = Attributed to blank contamination
J = Estimated

See Appendix A for tentatively identified compounds (TICs).

Site Name: Allied Fibers Frankford Plant
Project No.: 3814

TABLE 4-4
1990 RECOVERY WELL DATA
OCTOBER 2, 1990 BASE-NEUTRAL/ACIDS
ALLIED FRANKFORD PLANT
PHILADELPHIA, PENNSYLVANIA
(ug/l)

Chemical	R5	R6
Styrene	70.8	93.9
p-Cymene	9.0	23.5
2,4-Dimethylphenol	55.5	3,309.7
Diphenylether	41.3	90.1
Acenaphthylene	6.4	15.7
Acenaphthene	31.7	105.7
Dibenzofuran	27.8	215.0
Fluorene	24.4	107.5
n-Hexadecane	8.2	13.5
Phenanthrene	35.0	141.7
Anthracene	6.8	22.3
Dibenzothiophene	5.9	14.3
Carbazole	8.8	4.5
n-Eicosane	12.0	ND
Fluoranthene	11.0	39.4
Pyrene	6.6	25.8
n-Tetracosane	6.7	ND
Isophorone	24.7	23.6
Naphthalene	1,194.6	6,987.3
Biphenyl	29.9	108.3
Di-n-butyl phthalate	480.8	1,043.7
Bis(2-ethylhexyl) phthalate	846.3	639.0
Acetophenone	194.4 (A) 6,280.0 (B)	5,953.4 (B) 360.3 (A)
Thianaphthene	71.5 (A) 243.3 (B)	272.0 (A) 895.4 (B)
2-Methylnaphthalene	204.0 (A) 249.8 (B)	541.1 (A) 977.9 (B)
alpha-Naphthylamine	28.7 (B)	22.5 (B)
Benzoic Acid	408.2 (A)	538.9 (A)
Phenol	25,808.1	27,014.4
n-Tetradecane	ND	7.2
beta-Naphthylamine	ND	35.0
Di-n-octyl phthalate	ND	20.8
o-Cresol (2-methylphenol)	NA	877.3 (A) 37.3 (B)
p-Cresol (4-methylphenol)	NA	1,708.3 (A) 313.2 (B)
Hexanoic acid	NA	141.0 (A)

See appendix A for TICs.
ND = Not detected
NA = Not analyzed
(A) = Acid fraction
(B) = Base/neutral fraction

Site Name: Allied Fibers Frankford Plant
Project No.: 3814

TABLE 4-5
PHASE I MONITORING WELL RESULTS - ORGANIC COMPOUNDS
ALLIED FRANKFORD PLANT
PHILADELPHIA, PENNSYLVANIA
(All data in ug/l)

Chemical	MW-101	MW-102	MW-103*
Acetone	ND	ND	150,000 J
Benzene	ND	ND	57,000 J
Toluene	ND	ND	22,500 J
Chlorobenzene	ND	ND	860 J
Styrene	ND	ND	580 J
Xylenes	ND	ND	1,600
Cumene	260	4 B	<1,000
Phenol	ND	ND	59,000
2-Methylphenol	ND	ND	2,000
4-Methylphenol	ND	ND	3,600
2,4-Dimethylphenol	ND	ND	4,700
Benzoic acid	ND	ND	9,700 J
Naphthalene	33	ND	18,000
2-Methylnaphthalene	ND	ND	1,500
Acenaphthene	13	ND	ND
Dibenzofuran	7 J	ND	ND

* Results were arithmetic mean of duplicates, using 1/2 detection limit for non-detects.

See Appendix A for TICs.
ND = Not detected
B = Attributed to blank contamination
J = Estimated

In the MW-101 sample, PAHs and cumene were confidently identified. PAHs, methylstyrene, ethylstyrene, methylnaphthalene, and substituted phenols were tentatively identified. It is unusual to see PAHs in groundwater, and their presence in monitoring wells can be attributable to suspended sediment or as a result of high concentrations of solvents that affect solubility limits. This monitoring well was described on the sample log as being gray/brown and very cloudy. Some of the compounds detected in the MW-101 sample (e.g., cumene, methylstyrene, phenols) can be associated with site operations (NUS, 1991). The naphthalene and cumene detected in the MW-101 sample could be associated with the contaminated soil visually noted in boring no. 55 and the nearby LNAPL, respectively.

In the MW-103 duplicate samples, the following organic compounds were confidently identified: acetone, benzene and substituted benzenes, benzoic acid, styrene, phenol and substituted phenols, naphthalene, and 2-methylnaphthalene. The following compounds were tentatively identified: PAHs, substituted benzenes including trimethylbenzenes, substituted phenols, methylstyrene, ethylstyrene, methylnaphthalene, substituted pyridines, aniline, quinoline compounds, and biphenyl compounds. Virtually all of the confidently identified and most of the tentatively identified compounds can be associated with past site operations (NUS, 1991). For example, benzene and toluene were previously produced about 300 feet east-northeast of MW-103, whereas the acetone tank car loading area was located directly north of MW-103. The MW-103 sample was also described in the sample log as being grayish and cloudy; PAHs may possibly be attributable to suspended sediment.

Both filtered and unfiltered samples for metals were obtained from the monitoring wells. The metals results are presented in Table 4-6. It can be seen that, in general, the unfiltered results are much higher than the filtered results. This is not surprising, since the unfiltered monitoring well samples were described as being cloudy or muddy. Also, the metals are generally present at higher concentrations from the MW-101 and MW-103 samples than from the MW-102 sample. Metals detected in groundwater samples included arsenic, beryllium, chromium, lead, manganese, and nickel. The metals detected in the groundwater samples might possibly be attributable to the incinerator ash that may have been used to fill the creekbed.

Nonpurgeable organic carbon was also measured in the monitoring well samples. The results ranged from 5 mg/l (MW-102) to 11 mg/l (MW-101) to 255 mg/l (average of MW-103 duplicates).

TABLE 4-6
PHASE I MONITORING WELL INORGANIC RESULTS
ALLIED-SIGNAL, FRANKFORD PLANT
PHILADELPHIA, PENNSYLVANIA
(All data in ug/l)

Chemical	MW-101 (Unfiltered)	MW-101 (Filtered)	MW-102 (Unfiltered)	MW-102 (Filtered)	MW-103* (Unfiltered)	MW-103* (Filtered)
Aluminum	115,000	238	89,900	ND	14,550	ND
Arsenic	26.8 J	8.3	32 J	ND	19.5 J	7.8**
Barium	713	20 J	520	100 J	790	485 J
Beryllium	7.0	ND	4.0	ND	ND	ND
Calcium	73,600	39,300 J	66,500	65,300 J	283,500	352,500 J
Chromium	525 J	16	144 J	ND	240 J	ND
Cobalt	72	ND	58	8.0	ND	ND
Copper	445	ND	77	ND	95	ND
Iron	124,000	220 J	108,000	ND	146,500	209,000 J
Lead	600 J	2.8 B	48 J	1.2 B	208.5 J	ND***
Magnesium	24,100	3,590	48,600	30,900	82,200	90,000
Manganese	1,460	16 J	4,840	3,540 J	3,090	4,550 J
Nickel	200	ND	165	171 J	ND	185 J**
Potassium	14,000	4,290	20,700	12,900	17,500	19,650
Sodium	125,000	127,000	198,000	212,000	101,500	108,000
Vanadium	244	34	222	6.0	80	ND
Zinc	730 J	12 B	383 J	25 B	1,270 J	1,200 J

J = Estimated
B = Attributed to blank contamination
ND = Not detected

* Result is arithmetic mean of duplicates.
** Result is arithmetic mean of duplicate: 1/2-detection limit used for a non-detect.
*** One result was a non-detect, and one result was attributed to blank contamination.

4.5 CONTAMINANT FATE AND TRANSPORT

The fate-related properties of chemicals detected at the site are provided in Tables 2-1, 2-2, and 2-3. Details on the fate-related properties of the detected chemicals can be found in Section 2.0. In general, the volatile solvents such as benzene and toluene tend to migrate more rapidly in subsoil and groundwater than the metals or the PAHs. Certain semivolatile compounds, especially base-neutral extractables, tend to be somewhat mobile, although not as mobile as VOCs. Adsorption onto soils and sediments is much greater for metals and PAHs, and solubility in water is lower (Versar, 1979).

Cumene, with a specific gravity less than 1.0, would be expected to float on water. Cumene is also somewhat soluble in water.

For chemicals with Henry's Law Constants greater than 5E-3 atm x m^3/mol such as cumene and benzene, volatilization and diffusion in soil gas could be significant.

It should be noted that the reported average naphthalene concentration from the MW-103 samples, 19 mg/l, is greater than 50 percent of the theoretical solubility of naphthalene at 25°C. If the reported naphthalene values are all in the dissolved phase, these results would indicate that groundwater in the vicinity of MW-103 is nearly saturated with naphthalene. As discussed above, however, a portion of the naphthalene detected in the MW-103 samples could possibly be attributed to suspended sediment.

4.6 HEALTH AND ENVIRONMENTAL ASSESSMENT

Release of contaminants in Study Area 1 is indicated by the existing shallow groundwater data. It should be noted that these wells are not points of exposure. Although the available data indicate that the groundwater is contaminated, there are no known users of shallow groundwater. Because of the site's urban setting, all nearby water consumers are believed to be served by the City of Philadelphia public water supply. Therefore, risks via domestic use of shallow groundwater are not anticipated and will not be quantitated. Additional investigation of local water use will be conducted during the Phase II RFI.

Contaminant release to surface water bodies such as the Frankford Inlet or the Delaware River and transport to underlying aquifers are potential migration pathways that have not been established at this point. Phase II should involve collection of data to establish whether discharge to surface water or deeper sand/gravel unit occurs. A site-specific cleanup level that takes into account the migration pathways and actual receptors may be considered appropriate to address these potential pathways. This approach would involve establishing Maximum Allowable Exposure Concentrations (MAECs) at the potential points of exposure and using contaminant fate and transport modeling to determine appropriate cleanup levels. MAECs would be derived using conservative assumptions regarding potential uses of surface water and deep groundwater, if applicable.

Another potential fate pathway for contaminated groundwater is infiltration into sewer lines. Groundwater infiltration into sewer lines and cumene odors emanating from sewers have been reported in the past (Weston, 1980). The sewer lines lead to Philadelphia's Northeast Water Pollution Control Plant. This possibility is discussed in Section 3.5.2.2, and should be addressed during Phase II of the RFI, when the hydrogeologic conditions at the site are more clearly defined. Potential secondary exposures to vapors, if occurring, should be assessed in Phase II.

4.7 CONCLUSIONS AND RECOMMENDATIONS

4.7.1 Conclusions

The presence of an LNAPL layer lying on top of the groundwater table beneath a portion of the facility was confirmed during the Phase I RFI. The areal extent of the LNAPL was defined during Phase I; the layer underlies approximately 17 acres. A rough estimate of 200,000 to 500,000 gallons of LNAPL are thought to be present. The LNAPL is believed to be predominantly cumene.

Contaminated shallow groundwater was identified beneath most of the site. The only area appearing to be free of shallow groundwater contamination is the northern perimeter of the facility. Significant groundwater contaminants detected during Phase I consist of past and present facility products and feedstocks, including cumene, naphthalene, benzene, phenol, and acetone.

Shallow groundwater beneath the site generally is flowing to the west-southwest. This finding is somewhat unexpected, as shallow groundwater would be expected to flow to the east-southeast, toward the Frankford Inlet and the Delaware River, in the absence of man-made influences. Possible groundwater flow influences include sewer line infiltration/exfiltration and water line leaks. Local variations to the general shallow groundwater flow direction should be expected.

The groundwater recovery system, as operated during the RFI field investigation, does not appear to be creating a significant cone of depression.

4.7.2 Recommendations

The groundwater extraction system currently operating appears to be having only a limited impact on the LNAPL layer. The majority of produced water is recovered from recovery well R-6. The screened interval for this well is completely beneath the water table. Because this well reportedly does not have a significant drawdown under current operating conditions, only minor quantities of free product would be expected to be produced from this well. Consideration is currently being given to improving the LNAPL recovery system at the facility.

Because shallow groundwater contamination [and vadose zone soil contamination (see Sections 5 and 6)] are relatively continuous throughout the facility (with the exception of the northernmost SWMUs, where no further action may be recommended), the area of contamination beneath the Allied Fibers Frankford Plant should be treated as one Study Area/Corrective Action Management Unit (CAMU) for the remainder of RCRA corrective action activities.

The primary cause of shallow groundwater flow to the west-southwest was not determined during Phase I. To minimize investigation expenses, the primary factor(s) controlling shallow groundwater flow should be better defined during Phase II using a network of piezometers.

The extent of groundwater contamination was not determined during the Phase I RFI. (It was not a Phase I objective.) This extent should be determined in subsequent RFI phases. The piezometer network recommended above should be installed prior to the installation of any additional monitoring wells to minimize monitoring well placement/sampling expenses.

Based on the Phase I analytical results and visual observations, active groundwater remediation at the Allied Fibers Frankford Plant is not practicable. Subsequent investigations at the facility should concentrate on collecting sufficient information to evaluate the feasibility of a groundwater containment system augmented by natural flushing. Specific recommendations include confirming the continuity and low permeability of the silt-clay unit underlying the southern half of the site, as well as the completion of more detailed aquifer tests.

In the report "Summary of Findings, Conclusions, and Recommendations - Caustic Spill at East Tank Farm, Allied's Frankford Plant" (Woodward-Clyde, 1983), it is implied that one or more of the piezometers installed during the investigation was screened in the deep sand unit beneath the site. If this is the case, the piezometer(s) could be serving as a conduit for contamination of the deep sand unit. (On the other hand, the vertical gradient could be upward, and no threat would be presented.) The piezometers identified during Phase I in the caustic spill area should be investigated in more detail. If it is found that any of the piezometers extend into the deep sand unit, sealing these piezometers as a precautionary measure should be considered.